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Dear Karen and John

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Roald and Eva

March 1984

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EDITED BY

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ALCHEMY AND CHEMISTRY.

BY PROF. JOHN C. DRAPER, M.D.

An Address delivered before the Chemical and Natural History Society of the Lehigh University, at its Third Annual Celebration, June 23, 1874.

Gentlemen of the Chemical Society of the Lehigh University:

It is with extreme diffidence that I accept the honor of giving the annual address before your society. In your ordinary meetings, you have by numerous papers and discussions reviewed every chemical novelty that has appeared during the past year. In your annual celebrations, the silvery phrases of a Silliman, the calm critical acumen of a Chandler and of others eminent in the chemical world, have presented you with able and exhaustive summaries of modern chemistry, and have depicted in glowing colors the triumphs of the present and the glories that in the future await the devotees of our beloved science. The field of the present and the future being thus occupied, it only remains for me to burrow amid the mouldy records of the past, in the hope that perhaps something may there be found that may serve to attract your attention, or reward your patience with what it is to be hoped will not be an altogether unprofitable evening.

As we peer through the vistas of the past, the doctrine that has perhaps held the most prominent position in the minds of thinking men is that of transmutation. Viewing their own bodies, and the organisms of the animals by which they were surrounded, philosophers could not fail to recognize the fact that the crude vegetable material which was consumed as food was caused by these organisms to undergo marvellous changes, and to produce an infinite variety of new forms. At one time it built up the body of a writhing worm, at another it entered into the production of the gigantic proportions of some ponderous pachyderm; or, daintily cropped by a graceful gazelle, it became a creature whose beauty has been the theme of the poets and singers of all time. In the person of man himself, not only did it assume the highest development of which the material world was capable, but it was the fuel on which the immaterial fed and originated thoughts and ideas that controlled the destinies of men and nations.

Since the organisms in which these wondrous changes were wrought contained certain tubes for the conveyance of fluids and others for carrying air, and as there were running streams of water in the earth, and fissures through which air might gain access, what could be more natural than to suppose that in the bosom of the earth herself a like transmutation of base into fine material took place, and dull, unclean substances like lead, or even earth, in process of time, by a refining action, became pure gold.

> "For 'twere absurd
> To think that Nature in the earth bred gold
> Perfect in the instant. Something went before;
> There must be remote matter."

The idea of an analogy between the processes in the body of an animal and those in the earth having been accepted, it was evident that in the case of the latter, by virtue of its lower organization, greater periods of time were required to develop a lower into a higher form of matter. Nature might easily spend centuries in the transmutation of the useless into the valuable, but if man was to accomplish the same desirable result, he must seek for methods by which the time might be so shortened as to come within the brief period of his sojourn upon the earth. First among the agents that might be employed for this purpose was heat, for it refined gold from baser metals, and under its influence all plants were produced, and without it neither flowers nor fruits could be perfected. Hence it became an invariable element in all processes of transmutation, and to aid its action various substances were added, in the use of which powders of projection arose, the doctrine of the philosopher's stone. To gain this, earnest men sought with patient experiment and labor. Pious men prayed to be shown the path through which they might journey in search of their idol. Wild enthusiasts vaunted its value, and one of these in mystifying ecstasy cries:—

> "Your lapis philosophicus:
> 'Tis a stone,
> And not a stone; a spirit, a soul, and a body;
> Which if you do dissolve, it is dissolved;
> If you coagulate, it is coagulated;
> If you make it to fly, it flieth."

Ever seeking the unattainable; ever searching for the undiscoverable; the labor of the alchemists was not altogether in vain; for in their search after that

> "Great medicine,
> Of which one part projected on a hundred
> Of Mercury, or Venus, or the moon,
> Shall turn it to as many of the sun;
> Nay, to a thousand:"

they not only laid the foundations of the science of chemistry, but also contributed materially to its early progress.

The desire to discover the art of transmuting base metals into fine gold is coeval with the earliest history of man. The alchemists all agree in asserting that it was practised in the remotest times; some even claim that the knowledge of it was given to Adam.

"Will you believe antiquity? records?
I'll show you a book where Moses and his sister
And Solomon have written of the art:
Ay; and a treatise penn'd by Adam."

Others, on the contrary, think that since Tubal Cain is spoken of as being the first artificer in brass, this alloy was probably obtained in attempts to form gold, and consequently regard him as the first seeker for the philosopher's stone. Hermes, or Athotis, the son of Osiris, who was King of Thebes, nearly four thousand years ago, was regarded by Albertus Magnus as the successful discoverer of transmutation. In one of his works, he describes an emerald tablet, which was said to have been found by Alexander the Great in the tomb of Hermes, on which there was graven the mystery of the production of the universal Alkahest. It is as follows:—

"1. I speak not fictitious things, but what is true and most certain.

"2. What is below is like that which is above, and what is above is similar to that which is below, to accomplish the miracles of one thing.

"3. And as all things were produced by the meditations of one Being, so all things were formed from this one thing by adaptation.

"4. Its father is Sol, its mother Luna, the earth is its nurse.

"5. It is the cause of all perfection throughout the whole world.

"6. The power is perfect, if it be changed into earth.

"7. Separate the earth from the fire, the subtile from the gross, acting prudently and with judgment.

"8. Ascend with the greatest sagacity from the earth to heaven, and then again descend to the earth, and unite together the powers of things superior and things inferior. Thus you will possess the glory of the whole world, and all obscurity will fly far away from you.

"9. This thing has more fortitude than fortitude itself, because it will overcome every subtile thing and penetrate every solid thing.

"10. By it this world was formed.

"11. Hence proceed wonderful things, which in this wise were established.

"12. For this reason I am called Hermes Trismegistus, because I possess three parts of the philosophy of the whole world.

"13. What I had to say about the operation of Sol is completed."

"What a brave language here is! next to canting," and the mystery is self evident. It only remains to add that the enemies of Albertus Magnus, failing to find any account of the discovery of the famous tablet among the writings of the Alexandrian philosophers, boldly asserted that the whole statement was a deliberate deception on the part of the great magician. The followers of the latter, however, sustained the cause of their chief, and in evidence of the early knowledge of the art among the Egyptians, cited the thirty-second chapter of Exodus, in which it is stated that when the children of Israel worshipped the golden image, Moses took the calf which they had made, and burned it in the fire, and ground it to powder, and strewed it upon the water and made the children of Israel drink of it." How, they asked, could he have ground it to powder? how make it float on water? or how prepare it that the children of Israel could drink it? unless he had a thorough knowledge of alchemy. And where could he have obtained this knowledge but in Egypt, where we are told he was inducted into all the mysteries known to the priests?

In his works, the Jesuit Martini states that the art of transmutation was practised by the Chinese more than twenty-five hundred years before Christ, and Suidas, a learned lexicographer of the eleventh century, maintains that the golden fleece which Jason and the Argonauts sought

"Was no other than a book of alchemy
Writ on large sheepskin, a good fat ram-vellum."

In Rome, during the first centuries of the Christian era, those attempting to make gold or silver were punished, and in the fourth century some of the Greek ecclesiastics at Constantinople wrote on the subject. From this time until it appeared among the Arabians, nothing is said concerning it, and in reality the authentic history of the delusion only commences with Geber, who lived about the year 750, and who, although he did not discover the philosopher's stone, was the first to describe various substances, among which were corrosive sublimate and lunar caustic.

After the death of Geber, many Arabians devoted themselves to the study of gold-making and the preparation of the elixir vitæ. This in the eighth century led to the discovery of gunpowder by Marcus Græcus, who tells us that if in a marble mortar we pulverize together one pound of sulphur, two of charcoal, and six of saltpetre, and confine a portion of the mixture in a long tube closed at one end, and then apply fire to the open extremity, the tube will vomit flame as it flies through the air; or, if a portion be tied tightly in many folds of paper and then fired, it may be made to imitate thunder. Another important discovery of the same time was that of Djafar, who made nitric acid by the distillation of cyprus vitriol with alum and saltpetre, and who found that when sal-ammoniac was added to the distillate it possessed the power of dissolving gold.

Marcus Græcus was followed by Rhazes, who made sulphuric acid and absolute alcohol, obtaining the first by the distillation of green vitriol, and the second by the action of quick-lime on spirits of wine. It was these discoveries of the eighth century that caused alchemy to be defined as the science of the balance and thereby laid the foundations of true chemistry. It is curious to note that about the same time the Saracen Bechil made the artificial carbuncle, which was in reality phosphorus, for he says it is obtained by distilling together the extract of an animal fluid with clay, lime, and charcoal, and when removed from the water in which it is condensed it shines in the dark "like a good moon."

Following these was Avicenna, whose reputation as a physician and master of sciences was so great that

the Sultan made him Grand Vizier. He wrote numerous treatises on the philosopher's stone, and his admirers maintained that he would have discovered it had he not lost control of his passions and given himself up to debauchery. Albertus Magnus, of whom we have already spoken, was a worthy successor of Geber and Avicenna. He flourished about the year 1250, and though he was remarkably stupid during the first thirty years of his life he finally attained great distinction, and it was even believed that he could change the seasons, in evidence of which it is related that wishing to obtain a piece of ground belonging to William, Count of Holland, he invited him to a grand feast as he was passing through Cologne. It was midwinter, and the guests arriving in a storm, found the repast spread in the garden in which the snow was several feet deep. The count was indignant at such an insult and would only consent to take his seat after prolonged and earnest solicitations. As soon however as he had done so, the storm ceased, the snow melted, leaves, flowers, and fruits covered the trees, which resounded with the songs of the rarest birds. As a recompense, Albertus obtained the coveted piece of ground, when, to show the extent of his power, he caused all the surrounding pleasant things to pass away, and the storm reappeared in such violence as to force the guests to seek the friendly warmth of the kitchen fire. Gracefully as the story reads, it was in reality a fanciful account of an entertainment given in a hot-house, in which Albertus Magnus pursued the study of plants, and where he observed the sleep of flowers, and watched and wrote of their functions and habits.

Thomas Aquinas, the pupil and follower of Albertus Magnus, is also reported to have been a miracle worker. It is related that when he was annoyed by certain grooms who insisted on exercising their horses in the street where he resided, he made a small bronze horse on which certain signs were inscribed and buried it in the road at midnight. The following morning the grooms attempted in vain to urge their terrified steeds by the spot where the magic horse was buried, and after many fruitless endeavors finally abandoned the street to the magician. A famous contemporary of Aquinas' was Artephius, who boasted that he was one thousand and twenty-five years old, and that he had descended into hell in search of the philosopher's stone, there he had seen the devil sitting on a throne of gold with legions of imps and fiends around him. He was followed by Pietro D'Apone, of whom we read that when he paid out coin for the purchase of any article he muttered a charm, and the next morning the coin returned to him in spite of all the attempts of the rightful owner to keep it. He consequently excited the distrust of the people and acquired so bad a reputation that he was summoned before the tribunal of the inquisition and perished on the rack.

The thirteenth century witnessed the appearance of Raymond Lulli, one of the most celebrated of the alchemists. His reputation was so great that he was invited by Edward, king of England, to come to London. On his arrival, on pretence of doing him honor, he was lodged in the Tower, where he is said to have made six millions of pounds of gold out of iron, lead, pewter and mercury, which, when converted into coin, passed under the name of Raymond or Rose nobles. In the early part of his life Raymond Lulli was fond of pleasure, and though married to a lovely woman, was ever in pursuit of some new beauty, until at last he fell desperately in love with a fair lady called Ambrosia, who cured him of his passion by exposing to his astonished gaze a terrible cancer, and at the same time prayed that he would leave his evil courses. Under her influence he became a religious fanatic, and while attempting to convert Mussulmans in Arabia became himself a believer in alchemy.

Another and even more famous alchemist of the same epoch was Roger Bacon. He was by far the most learned man of his time, and made so many important discoveries that his contemporaries accused him of magic and caused him to be thrown into prison. Bacon was not only an experimenter but also an excellent linguist, reading with ease all works in the Greek, Latin, Hebrew, and Arabic languages. He was acquainted with the properties and uses of lenses; he invented spectacles, and described the action of telescopes and microscopes, for he says that lenses may be so ground as to read the smallest letters at great distances, or to enable one to count minute grains of sand and dust, because of the greatness of the angle under which such objects may thereby be examined. He is reputed to have been the first to employ gunpowder for the propulsion of bullets.

The story of Nicholas Flamel, who also lived in this century, is a good illustration of the manner in which the belief in transmutation was sustained. He was well educated, a good linguist, but very poor. Having purchased a book treating of alchemy and purporting to have been written in Latin by Abraham, the prophet, priest, and lawgiver, he devoted himself to the study of the art. The book contained a series of pictures, one of which represented a king superintending soldiers who were butchering great numbers of young children, while others collected the blood and put it into a kind of tub, in which images of the sun and moon were bathing themselves. Nicholas pondered over these pictures for more than twenty years without arriving at any satisfactory result. Then, persuaded by his wife, Petronella, he went to Spain to consult a famous Rabbi, and after his return commenced the transmutation of mercury into gold and silver, and died at the age of 116 years, possessed of enormous wealth, the bulk of which was left as endowments to numerous hospitals and churches. Those who claim to be better acquainted with his real history give a very different account of the origin of his wealth. They state that he was a miser and usurer, and that the true object of his journey to Spain was to collect debts owing to residents in Paris. For this service he charged a commission of one hun-

dred per cent., and thus laid the foundation of a fortune that finally made him the chief money-lender to the dissipated youth of that city.

The fifteenth century produced many famous alchemists. Among these was Basil Valentine, the monk of Erford, who wrote on transmutation. He was also the author of a book on the metal antimony, which name is said to have been derived by him from the injurious results that followed experiments made with its compounds on his fellow-monks. Bernard de Treves was another firm believer in the philosopher's stone. He was very rich and very credulous, as is shown by the attempt he made to produce gold with the assistance of the alchemists of Vienna. At a supper given by Treves, Master Henry, a famous alchemist of the town, was present. He confessed his previous failures to make gold, but proposed an experiment which he confidently asserted would in five days quintuple a given amount of that metal. It was decided to make the attempt, and forty-two marks of gold were subscribed. Bernard being the richest gave ten, Henry five, and the others one or two. The forty-two marks were then put into a crucible with mercury, lead, salt, egg shells, copperas, aquafortis, and manure. Heat was applied to the mixture for three weeks, at the close of which the crucible contained only sixteen marks instead of forty-two. What became of the rest was never discovered. Bernard de Treves also obtained a great reputation for the love philters he prepared for Charles V. of France, the efficacy of which he quaintly tells us he ascertained by experiments on maid-servants.

The name of Eck de Sulzback also deserves mention, for he first crystallized various metals and gave directions for the formation of the tree of Diana. He found that mercury increases in weight when heated, and says, "This augmentation of weight comes from this, that a spirit is united with the metal; and what proves it is this, that this artificial cinnabar, submitted to distillation, disengages that spirit," thus anticipating the observation of Priestley by nearly three hundred years.

Of all the upholders of alchemy one of the greatest was the Lord of Rays, a Marshal of France. He possessed a princely fortune and married an heiress of almost equal wealth. By a course of unparalleled extravagance his enormous riches soon melted away and he resorted to alchemy to restore his fortunes. While thus engaged rumor stated that his castles were the scenes not only of the wildest extravagance but also of hideous crimes, among which murder was not the worst. Young children of both sexes disappeared, some of whom were traced to the castles and there lost. No one dared to accuse the powerful marshal, but nevertheless his name became the bugbear of the peasants, and no child could be induced to go within miles of the castle walls. Gradually his estates were sold, and the marshal fell more and more into the power of an Italian who ministered to his evil courses, and led him on to dreams of future wealth, until he had obtained the bulk of the remaining property and was only waiting an opportunity to escape. In this he was disappointed, for children continuing to disappear the marshal and his Italian assistant were thrown into prison, and condemned to be burned alive, after it was found from the confession of the Italian that the insatiable lust of the marshal had been supplied at the expense of more than one hundred children, all of whom he had at various times stabbed that he might enjoy their death agonies, and by propitiating the devil induce him to reveal the secret of the philosopher's stone.

A contemporary of the Marshal de Rays was Jacques Coeur, who arose from a very humble station to the highest position in the court of Charles VII. of France, and amassed enormous wealth by speculations in grain, honey, and wines. With the improved state of his fortunes he became insolent to those who were his inferiors in wealth, and when rumor hinted that he had forged the king's seal and debased the coin of the realm, he filled his house with alchemists, wrote a work on alchemy, and gave out that his wealth had been obtained by the fortunate discovery of the philosopher's stone. This, however, did not save him, for it was proved that he had committed the forgery; he was consequently thrown into prison, fined, and finally released, and died at Cyprus the richest man on the island.

Toward the close of the fifteenth century Cornelius Agrippa was the most famous of the alchemists. He left many works, one of which was on the superiority of the female sex. Among the marvellous stories told concerning him, is one to the effect that, being about to leave his house for some days, he gave the key of his laboratory to his wife, charging her not to allow any one to enter. A young, handsome student, who lived in the house, by his compliments to the lady's charms, induced her to permit him to use the key. On entering the apartment a great book of spells fastened his attention, and he began to read. The first word he uttered was answered as he thought by a knock at the door. Continuing to read he was interrupted by a louder knock, which was followed by the unbidden entrance of a demon, who demanded why he had been summoned. The student in terror denied that he had done so, whereupon the demon, enraged that one of the uninitiated should have presumed to trifle with him, caught the unfortunate wretch by the throat and strangled him. On the return of Agrippa the house was occupied by a host of devils, who were indulging in every conceivable mischief. Forcing his way through the throng to his study, he there found the dead body of the student, and at once summoned the fiend to account for his act. In spite of the remonstrances of the latter, he was obliged to reanimate the body and promenade with it through the streets of the city. This was done in the sight of all the inhabitants, but at sunset the body again fell inanimate, and it was currently reported that the student had died of apoplexy. On examining the corpse, however, the signs of strangulation and bruises about the neck were

so evident that Agrippa was compelled to fly from the town to save his life.

In the seventeenth century faith in transmutation was still unbroken, and Von Helmont, Boerhaave, and others declared their belief that the art would yet be discovered. As evidence of this we may cite the statement of Helvetius, their contemporary, who declares that he saw a stranger convert an inferior metal into gold at the Hague in 1666. Even Glauber, the discoverer of the salt that bears his name, was a believer in the attractive delusion, and it is said that the discovery we have mentioned was made while endeavoring to find the philosopher's stone among the *terra damnata* of chemical operations. At last suspicion was generally aroused regarding the claims of the alchemists, and in a report read by Geoffroy before the Royal Academy of Sciences at Paris, on the 15th of April, 1722, the tricks were exposed by which impostors had practised on the credulity of the public.

From this document we learn that the ordinary way of producing the appearance of transmutation was to employ a crucible or melting pot with a double bottom, the exterior being of some infusible material and the interior of suitably colored wax. In the space between these gold or silver was placed. Lead or quicksilver, the latter being preferred on account of its volatility, was then introduced into the vessel together with the powder of projection. Heat being applied the wax and the base metals disappeared, and a button of gold remained at the bottom. Sometimes a true crucible was used, and the gold or silver introduced into the fused materials by means of a hollow wand or stirrer, the interior of which had been filled with the powder of the metal the production of which was desired. Lead, in which holes had been drilled and filled with gold and then closed up was also employed, or a piece of gold was washed with mercury and then transmuted into pure gold by an acid.

Where only a part of the baser metal was to be converted, nails or bars, consisting half of gold or silver and half of iron or some other metal, were prepared, the gold or silver being painted to resemble the other metal. The removal of this coating or transmutation was accomplished by means of alcohol or some liquid that could dissolve the paint. A nail of this description was at one time preserved in the museum at Florence, and the knife that belonged to Queen Elizabeth, which was half gold and half steel, was of the same nature. Such objects as coins, half gold and half silver, were at one time very common, and were distributed by alchemists as evidences of their power in order to entrap the credulous.

From these examples it is evident that the belief in the philosopher's stone owed its vitality chiefly to the deliberate deceptions we have described; the operators in many instances desiring to mislead the public regarding the manner in which they had suddenly acquired fortunes obtained by fraudulent or unjustifiable means; in others, to procure expensive articles under pretence that they were to be employed in their operations, but really to sell them again; and sometimes to enjoy the prestige which attended the seeming possession of so enviable a power as that of gold making.

To carry out their purposes and retain a knowledge of their processes among the initiated the alchemists employed signs to signify the substances used. They thus clothed their writings in an unintelligible jargon, of which the following aphorism of Urbirgerius is an excellent example: "If our Virgin in her confinement before she is set at liberty does not manifest her extreme beauty with all her internal, divers, delicate colors, wonderfully charming and very pleasant to the eye, it signifies that she has not sufficiently enjoyed the spiritual communion of the Dragon." The operation of cupellation could not be rendered more obscure, nor could anything be better calculated to mystify the outside world than a formula like this, and even now we cannot but admire the ingenuity which devised it, and justified it on the ground that—

> "Was not all the knowledge
> Of the Ægyptians writ in mystic symbols?
> Speak not the Scriptures oft in parables?
> Are not the choicest fables of the poets,
> That were the fountains and first springs of wisdom,
> Wrapped in perplexed allegories?"

Though the belief in the transmutation of metals received a severe blow from the writings of Geoffroy, and was further undermined by the development of rational chemistry, there are many who still indulge in a lingering hope that it is possible

> "That you should hatch gold in a furnace, sir,
> As they do eggs in Egypt."

And insist that

> "No egg but differs from a chicken more
> Than metals in themselves."

And when told—

> "That cannot be
> The egg's ordained by Nature to that end
> And is a chicken in potentia."

They answer:—

> "The same we say of lead and other metals,
> Which would be gold if they had time."

Among those who held these doctrines was Girtanner, of Göttingen, who prophesied that "In the nineteenth century the transmutation of metals will be generally known and practised. Every chemist and artist will make gold, which will contribute more than anything else to prolong life, poisoned at present by the oxides of copper, lead, and iron, which we daily swallow with our food." Even Davy, the discoverer of many metals, thought it by no means impossible, and eminent chemists now living urge that it is not rational to believe that there should be some forty elementary metals many of which are so nearly allied in their chemical and physical properties as often to mislead experts in their identification. Such a doctrine implies that some of them must be compounds of others, or, in other words, that one may be transmuted into another. Some even go so far as to think that this may be accomplished by the action of "the glorious sun," who

"plays the alchemist;
Turning with splendor of his precious eye
The meagre cloddy earth to glittering gold."

The golden dreams of the alchemists, with their essences, quintessences, and spirits, and their hoped-for fruition through the agency of the sun, may have passed away, but we should be very grateful to the men who, in their attempts to enchain the Lord of Light and force from him the coveted secret of transmutation, opened the way to discoveries which in later times have given to science her greatest triumphs. The mysterious changes impressed by light upon the lunar caustic of the alchemist, under the hands of the photographer are now developed into pictures of surpassing beauty and unswerving faithfulness; even colors which were thought to have no action on the silver salts are now forced to yield an immediate impression; all that is needed to give absolute perfection is the reproduction of the natural tints of the original, and there can be but little doubt that many of us will live to see this accomplished. Already we appear to be upon the brink of the discovery. Facts which for a long time have lain dormant or unnoticed are again exciting a lively interest, and long-forgotten experiments of Herschel on the reproduction of natural colors in photographs cannot fail, with increased knowledge and improved appliances, to yield satisfactory results.

In its application to the spectroscope the transmuting photograph opens a vista of bewildering extent, and, remembering the marvellous power it possesses of depicting things that cannot be seen by the eye, and of making exact records of changes that are taking place in invisible rays of light, our minds fail to grasp in their fullest extent the results that science is destined to reap in the future from this invaluable assistant. Though millions of miles away the sun himself has been forced to tell the story of his composition, and to print the lines that record with mathematical precision the presence or absence of every element. So star after star will in like manner be called upon to place its evidence on the photographic plate. When we turn to the organic world and view the legions of objects that possess a definite action on the spectrum, and which in many instances can only be seen through the agency of the photographic plate, we are lost in the mere contemplation of the possibilities that await the future workers in this field of scientific research.

We have said that exact chemistry originated in the latter part of the eighth century in the discovery of the acids, and the general introduction of the use of the balance in the preparation of compounds. The next great advance was the discovery of oxygen by Priestley just one century ago, and the coincident outlining of laws and formation of a nomenclature by Lavoisier and his compeers. Since that time the advance of the science has been so rapid that it now presents subdivisions into Theoretical, Technical, Practical, Analytical, and numerous special branches. In each of these there are hosts of ardent workers whose labors are day by day adding to the grand mass of facts that builds up the fabric of modern chemistry. The last and most important movement in this protean science is the New Chemistry which owes its acceptance chiefly to the work of Hoffmann on Modern Chemistry. The salient difference between the chemistry of a quarter of a century ago and that of the present day is that, while in the former *weight* was of the utmost importance, *volume* has now taken the first position, and all theoretical deductions and practical manipulations are made to depend rather upon measures than balances.

The law of Avogadro is the starting point of this new development of our science, and bears the same relation to it that the law of gravitation bears to astronomy. This law of Avogadro briefly asserts that "Equal volumes of all substances, when in the gaseous state and under like conditions, contain the same number of molecules." We can hardly be surprised that, with such an implement wherewith to assault the storehouse of Nature's secrets, men like Sir William Thompson have presumed to calculate the number of molecules in a given quantity of gas, and to state that in the perfect condition at 32° F. and 30 inches of pressure these substances contain neither more nor less than one hundred thousand million million million molecules in the cubic inch. Others appealing to similar means have permitted their imagination to delineate fanciful diagrams of the modes in which atoms and molecules are associated together, and by kaleidoscopic representations indicate the graceful movements of these fairy forms, as they link themselves first with one partner and then another, in their ceaseless flittings through the organic and inorganic world.

Fancies like these may excite a smile akin to that provoked by the doings of the alchemists, but they are the natural outgrowth of the imagination, without which knowledge would fail to make the rapid advances we have seen in recent times. As lovers of our science, then, let us seek to cultivate a wholesome play of this faculty of the mind, which

"bodies forth
The forms of things unknown, * * * *
Turns them to shapes, and gives to airy nothing
A local habitation, and a name."

In conclusion, gentlemen, permit me to congratulate the University, first, upon the munificence which has enabled it to assume its present satisfactory condition, and second, upon its Chemical Society. By the energy of its members much has already been done to extend the reputation and fair name of the institution under whose shadow it was cradled. To you who have its nurture in your care, I would say, See that it becomes a guiding star which wise men from afar shall seek; and let it be your aim to

"Make Knowledge circle with the wind,
But let her herald Reverence fly
Before her, to whatever sky
Bear seed of men and growth of mind.

Watch what main currents draw the years;
Cut prejudice against the grain:
But gentle words are always gain;
Regard the weakness of thy peers.

Not clinging to some ancient saw,
Not mastered by some modern term,
Not swift or slow to change, but firm
And standing steadfast by the law."

MONUMENT TO LIEBIG.

Sir: The pupils of Justus Liebig, propose to erect a fitting monument to the memory of their master, and now appeal to the chemists of all nations to aid them in the effort to raise a sum sufficient for the purpose. It has been decided to erect one monument at Munich, where Liebig spent the later years of his life, and, if the fund subscribed shall suffice, to place another—perhaps a copy of the first—at Giessen, the scene of his earlier labors.

You are earnestly invited to subscribe for the above purpose such a sum as you may feel able to give in recognition of the eminent services which the illustrious chemist rendered to science and through it to mankind. You are also requested to indicate your preference, should you feel any, for the bestowal of your individual gift toward the Munich or the Giessen monument.

Subscriptions may be sent to either of the undersigned, who will forward the sums contributed to the Central Committee at Berlin.

Prof. J. Lawrence Smith, Louisville, Ky.
Prof. E. N. Horsford, Cambridge, Mass.
Prof. Wolcott Gibbs, Cambridge, Mass.
Prof. C. A. Joy, Columbia College, E. 49th St., N. Y.
Prof. C. F. Chandler, Columbia College, E. 49th St., N. Y.

CONTRIBUTIONS FROM THE LABORATORY OF THE ILLINOIS INDUSTRIAL UNIVERSITY.

I. Nitrous Acid in Plants.

BY P. GENADIUS.

The occurrence of nitrous acid in plants is a subject of great importance considered in a physiological as well as in a chemical point of view.

Besides the experiments made on this subject in the laboratory of the Illinois Industrial University during the last year—part of which have already been stated by our Prof. Stuart before the Horticultural Society of Champaign and afterwards published in the Transactions of the Horticultural Society of the State of Illinois*—Schœnbein was the first and the only one, so far as we know, who treated of this subject.

He detected nitrous acid in the juices of different plants with the common reagent for that acid—namely a solution of potassium iodide, starch, and sulphuric acid—which reagent gives to the liquid containing nitrous acid a fine blue color.†

At a later period,‡ however, he attributed this bluing to the presence of active oxygen, and not any longer to nitrous acid; and this, we suppose, because of the difficulties he encountered, and which we also encountered in repeating his experiments.

Since Schœnbein's investigations several chemists in Europe have experimented on the formation and presence of nitrous acid in the soil and in different waters.

The experiments of Mr. Jeaunel* in the formation of nitrous acid in the soil have doubtless unfolded one more page in the book of the mysteries of chemistry; they showed plainly how, by the alternate wet and dry weather, the soil, absorbing and assimilating the nitrogen of the air, becomes an inexhaustible nitrifier.

To-day, in the German laboratories, nitrous acid in water seems to be one of the questions of the day. H. Kaemmerer,† Professor of Chemistry in the Royal Industrial School of Nuerenberg, calls the attention of those interested in this subject to the liability of reducing the nitric acid of the water under examination to nitrous acid, in the presence of organic matter, through the action of so strong an acid as the sulphuric; and hence he proposes to use, instead of sulphuric, citric acid, it being very much weaker. C. Aeby, Professor of Chemistry in the University of Berne, attributes‡ the bluing obtained in testing waters for nitrous acid, at least in the majority of cases, to the presence of finely divided and suspended humate of iron (!) present in many drinking waters. Finally, Fresenius,§ in order to remove all these objections, treats the water to be tested with $C_2H_4O_2$ and subjects it to distillation. The nitrous acid distils over, leaving behind all organic substances and the nitric acid. This is, in short, so far as we are aware, the substance of what has been done on nitrous acid up to the present time.

Our own experiments have been conducted simply in reference to nitrous acid in plants. We tested several plants by using the common reagent of this acid—a solution of potassium iodide, starch, and sulphuric acid—and in some of them, such as *Lactuca sativa*, *Lycopersicum esculentum*, *Taraxacum densliones*, *Dalia variabiles*, *Batata edulis*, a blue colorization of various degrees of intensity, readily appeared; in others, such as *Solanum pseudo-capsicum*, *Plantago major*, *Daucus carota*, *Solanum tuberosum*, the bluing appeared gradually and feebly; in others again, such as *Asparagus officinalis*, *Rheum rhapsonticum*, *Vitis labrusea*, *Cannabis sativa*, *Zea mays*, and other species of grasses, no bluing whatever appeared.

We also examined the juices of the different parts of plants separately, and we found, as a general rule, that the young leaves and sprouts of the plants giving the blue reaction do give it more intensely and more readily than the older and more fully developed leaves, stems, etc. Moreover we found that the skin of the young tubers, the young leaves and the sprouts of the Irish potato, the sweet potato, and the dahlia give the blue reaction readily; whereas the interior of the tuber, the fully grown leaves, and the stems of these plants do not

* Transactions of the Ills. Hort. Society, 1873, vol. vii. p. 246.
† Journal für praktische Chemie, vol. lxxxviii. 1863.
‡ Transactions of the Society of Natural History of Basle, 1868. Also Journal für praktische Chemie, vol. cv. 1868.

* Comptes Rendus, November 18, 1872.
† Zeitschrift für Analytische Chemie, Wiesbaden, No. 4, 1873.
‡ Ibid.
§ Ibid.

give any blue reaction. Would not one, by these experiments, be inclined to think that this substance we detect in the parts of the plant yet in process of growth —whatever it may be, nitrous acid or active oxygen— is a very important one for the growth of the plant?

The test we used for nitrous acid is the best we have. Unfortunately though it is a very imperfect one; for, according to Prof. Stewart's experiments, there are several substances which, although perfectly free from any nitrogenous compound, do give, by means of the nitrous acid reagent, the blue reaction as if they contained nitrous acid. This is the case with magnesium carbonate, manganese carbonate, aluminium carbonate, sesquioxide of chromium, spongy platinum, and others. Also we know that if crystals of permanganate of potash be heated in a bulb connected with a test-tube containing a solution of potassium iodide and starch, this solution will soon become dark blue. We know, moreover, that ozone acts similarly. A slip of paper moistened with the nitrous acid reagent and brought near an electrical machine in action, will readily become blue. Binoxide of hydrogen will also blue a solution of potassium iodide and starch. These facts bring us now right to the question whether the bluing in plants is really caused by the presence of nitrous acid or by that of Schœnbein's active oxygen—that is to say, some allotropic modification of oxygen whose properties we do not as yet very well understand.

More data were necessary in order to decide this question. We tried, therefore, to obtain some new facts by new experiments. And we found, first, that the juices of all plants which, while fresh, give the blue reaction readily, by standing some minutes lose this property — a fact, however, as afterwards we found, already observed by Schœnbein. Second, that if lettuce juice be allowed to stand for about twenty-four hours, the blue reaction can be obtained again—indeed we did obtain it every day during three weeks. This peculiar property of lettuce we did not find in the juice of dandelion, Irish potato peelings, or of apples. And third, that the organic matter of some juices has the power of destroying nitrous acid. To the juice of Irish potato peelings was added some potassium nitrite; after standing fifteen days no blue reaction was any longer given; the nitrous acid was destroyed or converted into nitric.

These three experiments show, first, that different juices act differently on the blue-giving substance they contain; and secondly, that the vegetable matter of the juices destroys or changes in some way the nitrous acid.

We also found through careful experiments that the bluing of a juice disappears by application of heat without appearing again. This would bring anew the question whether this bluing is really caused by the presence of nitrous acid. The following fact seems to answer affirmatively the question:—

A reasonable quantity of potassium nitrite was added to the juice of dandelion and of young leaves of Irish potatoes, and then treated for nitrous acid in the usual way. A very deep blue color certainly appeared immediately, but after application of heat this color disappeared and did not reappear. Now, if we take a solution of KNO_2, free from all vegetable matter, and add the reagents, and apply heat, the blue color formed will disappear, and on cooling in a few minutes reappear; but if heated well a second time it becomes, and remains after cooling, colorless. It would seem therefore that the application of heat in these two cases converts the nitrite into a nitrate, and in the first case (in the portion containing the juice) it does so more rapidly because of the presence of the organic matter, which, in some way, seems to favor the conversion of the nitrite into a nitrate. Of this fact we became assured when we detected nitric acid in the solution, with ferrous sulphate and strong sulphuric acid.

We also sought for nitrous acid in different juices, applying the method proposed by Fresenius for the detection of this acid in water. Having treated the juice of lettuce (fresh as well as old) with acetic acid and then distilled it, the distillate gave us instantly the blue reaction when the usual nitrous acid reagent was added. The juice of apples, of potato peelings, and potato sprouts, treated in the above way, gave also the blue reaction, but only after six hours' standing. Here we may say that the results obtained from standing juices must be taken into consideration only when the acetic acid has been used, because the sulphuric would turn blue the potassium iodide and starch alone if allowed to stand for a short time, whereas this does not occur if acetic acid be used.

The last and very important datum we have to present here, and which appears, at least to us, to resolve the nitrous acid question by establishing, so to say, the presence of this acid in plants, is the presence of nitric acid in plants. We detected nitric acid in every juice we tested with the usual reagent. But since organic matter often may give with this reagent the same reaction (a brown ring) we proceeded to prove its presence in the juices of plants in the following very simple way: The juice is boiled until the gross organic matter (the chlorophyl and vegetable albumen) separates out; then it is filtered and concentrated to a very small quantity. This concentrated portion we allow to stand until crystillization takes place. From some plants we treated in this way, such as *Cannabis sativa*, *Amarantus albus*, *Lactuca sativa*, *Batata edulis*, *Lycopersicum esculentum*, *Lappa major*, *Artemisia absinthum*, we obtained an astonishing and wholly unexpected quantity of needle-shaped crystals of potassium nitrate; in others the quantity was not so large as in Irish potato leaves. In apple, asparagus, and dandelion, although the reaction for nitric acid, with ferrous sulphate and sulphuric acid, was repeatedly obtained from their juices, it was impossible to obtain any nitre crystals, and this, probably, because of the nature of the vegetable matter, it being thick and saccharine, and hence obstructing the formation of crystals.

Here we may remark, in passing, that certain plants, as Mr. A. Boutin has already shown in two communica-

tions he presented to the French Academy of Sciences,* contain so large a quantity of potassium nitrate that they could be used as green manures with great advantage.†

In concluding we say that the results of this last experiment seem to us to offer a very strong evidence of the presence of nitrous acid in plants, for the formation of nitric acid would be preceded necessarily by that of the nitrous, the latter being, as it were, a stepping-stone to the former. So that the bluing we get from the juices of the different plants we experimented with is, at least in the majority of cases, probably caused in large measure by the nitrous acid present in these juices, with which, as soon as the oxygen of the air comes into contact and the chemical changes (fermentation and decomposition) begin, this acid either is destroyed or changes into nitric.

FALLACIES AND UNCERTAINTIES OF PROF. WURTZ'S TEST FOR FREE OXYGEN IN WATER.

BY H. ENDEMANN, PH.D.

Professor Wurtz has brought before the public, first in his article on the water of the Passaic River, and later, in March, 1874, at a meeting of the Lyceum of Natural History, a test used by him for the determination of free oxygen in water.

He states, that a solution of pyrogalline slightly acidified with hydrochloric acid is used by him, in connection with a solution of carbonate of soda, to indicate, by the color which the water assumes after treatment, the amount of free oxygen present. In order to determine the actual weight of oxygen he uses a standard solution of permanganate of potash, adding this reagent to a water free from oxygen, but containing the same reagents as above, until the color of both vessels has become equal. From the amount of permanganate used he calculates his oxygen.

Now in making this second experiment it will be observed that there is always a finely divided precipitate formed of either protosesquioxide, sesquioxide, or peroxide of manganese (which, I did not determine), which being itself colored interferes materially with the observation of the color of the liquid. This difficulty, however, might be overcome by substituting ammonia for carbonate of soda; the liquid will then remain clear. The most difficult question which now however will arise is the following: Do free oxygen and permanganate of potash act in the same manner on an alkaline solution of pyrogalline? This must certainly be denied. It is not only the coloring material which is produced by the action of oxygen on pyrogalline, but various other substances, which are either classified amongst organic substances or inorganic substances like carbonic oxide, all in *statu nascenti*, and therefore of higher reducing qualities than if they had been pre-existing. These will also enact their influence on the permanganate, and the consumption of this reagent will therefore be larger than is warranted by the consumption of oxygen necessary for the chemical changes produced by free oxygen. If chemists shall adopt Mr. Wurtz's process, he should satisfy them that both processes are perfectly alike, and in this, I am confident, he will fail.

To add permanganate to an acid solution is equally impracticable, as the color, if not entirely disappearing, assumes at least a far lighter shade.

I come now to consider a most extraordinary statement of Prof. Wurtz, made in connection with this test. He states that even long boiling will not remove the oxygen so completely from water, that it may be used for his test; he says water may be boiled down to the last drop, and this will contain free oxygen. As this would materially affect our methods of gas analysis, I thought it worth while to make the experiment. If the boiling be done in an open porcelain dish it is possible that such results may be obtained as mentioned by Mr. Wurtz. The experiment as I made it is very simple and can easily be made without long preparation. A glass flask is filled to the neck with water, and this boiled for three minutes; then, while boiling, it is drawn off by means of a siphon into a cylinder (the mouth of the siphon reaching to the bottom of the cylinder), which should not hold more than one-half of the fluid contained in the flask. The first portion of the fluid, which necessarily comes in contact with air, can thus by gradual displacement (allowing the cylinder to overflow) be removed from the cylinder. The cylinder is then closed by a rubber stopper, and either allowed to cool before testing its contents or the reaction may even be made while the fluid is hot. In no case I have been able to obtain the slightest coloration (using pyrogalline and soda) if the experiment was made with the precautions just mentioned. This proves that boiling will remove all oxygen from the water. Mr. Wurtz did fail in this experiment, and therefore proposes the following method, based upon his nominal discovery that carbonic acid gas passed through or, better, developed in a fluid will expel all oxygen. To this conclusion he comes merely by the fact, that his reaction with pyrogalline and carbonate of soda fails in this case to prove its presence. Carbonic acid, like any mineral acid, added to a water colored by Wurtz's test, will partly decolorize the fluid. Or we may modify the process, by adding to a water, of which it is certain that it will color by the pyrogalline test, first pyrogalline and then a solution of carbonate of soda, saturated with carbonic acid gas; no color is produced. This experiment therefore shows that the presence of free carbonic acid secures the stability of the pyrogalline, and this must be looked to as the only reason that no

* Comptes Rendus, January 26th and February 17th, 1873.

† Mr. Boutin found in the Amarantus blitum (a species resembling the A. albus or common pigweed) 12 per cent. of potassium nitrate; in the A. ruber 16 per cent., and in the A. atropurpurens 22.77 per cent. He also remarks that the A. blitum "would have over guano an appreciable advantage." Certainly the value of the two other species would be still greater.

coloration can be obtained in water containing free carbonic acid. If to this solution caustic or even carbonate of soda be added in sufficient quantity to combine the acid, the color is at once produced.

In conclusion, I will state that a substance known so little, in itself or regarding its products of decomposition, is, in my opinion, very unfit for quantitative determinations, and unless Mr. Wurtz will study its properties to such an extent as to satisfy chemists regarding them, its use must remain confined to qualitative chemistry.

REPLY BY H. WURTZ.

Editors of American Chemist:—

Gentlemen:—Your kindness in submitting to me the above attack of Dr. Endemann, for reply at the time of publication, is made very appropriate by the fact—rendering this case somewhat anomalous—that but a part of the results sought to be overthrown by that gentleman is yet before your readers, either in your own journal or in any other; and this part only in a concise paragraph, collateral to another subject. The special communication to the New York Lyceum of Natural History which Dr. Endemann strives altogether to discredit, has not yet appeared in print anywhere, and was stated at the time to be but preliminary, read only from notes, and its object mainly "*pour prendre date.*"

Had you not taken this eminently just step, the premature assault of Dr. Endemann might easily have produced in the minds of some readers prejudices unjust to me, such as readily proceed from a hearing of the adverse side only of a case. I trust also in the peculiar circumstances of this case, as a sufficient and obvious excuse for the length of my reply and its possible diffuseness.

First, I would point out that, while Dr. Endemann entitles his note "Fallacies and Uncertainties" of my test, yet, singularly, he himself relies solely on the said test to settle the points he puts in dispute, namely, the freeing of water from oxygen by boiling and by carbonic acid; apparently, for his own purposes, admitting its infallibility and certainty, and conceding all that I could possibly claim for it, so far as these applications go.

There are three distinct positions of mine attacked by Dr. Endemann, which it will be convenient to take up in an order differing from his.

1. *Expulsion of Oxygen by Ebullition.*—I have at no time put forth *positively*, as Dr. Endemann seems to think, the assertion that water *cannot*, under especially favorable conditions, be deprived altogether of dissolved atmospheric gases by boiling. The proposition I did put forth, digressively, and therefore concisely, may be found in the American Chemist for September, 1873, page 102, as follows: "Water *may* be boiled indefinitely, even boiled away altogether, but retain to the last *traces* of free oxygen." The italics I introduce speak for themselves. My only positive and unconditional assertion has been that, in delicate researches dependent on complete absence of oxygen—such, for example, as some of those on spontaneous generation—we could have no certainty, until the discovery of this pyrogalline reaction, or some similar direct and simple test.

Dr. Endemann appears to find, on the contrary, that the complete expulsion of oxygen is easy and certain, even by only three minutes boiling; and, in demonstration of his proposition, resorts to and relies on the very test discovered and proposed by me.

That it is not *easy* to expel air by boiling alone, has long been held by chemists who will be treated with less disdain by Dr. Endemann. Bunsen is one example. In his "Gasometry" (Roscoe's Edition), pp. 142–3, he directs—to free water from air—to "boil briskly for several hours," to "pass whilst still boiling into a flask" with drawn-out neck, in which "the water is again boiled for half an hour" before sealing the neck.

Before leaving Bunsen, I wish to quote also from page 155, where—regarding the purification of water to determine the absorption of air thereby—he directs that the vessel employed should not have been "previously used for any organic preparation, as the slightest trace of volatile organic matter is sufficient to convert a part of the oxygen into carbonic acid." In my Lyceum communication, I stated that slight traces of sulphuretted hydrogen, sulphide of ammonium, and many other substances, totally destroy traces of dissolved oxygen. I might therefore ask Dr. Endemann—were I to emulate his example of assuming slovenly carelessness, in this delicate kind of work, on the part of others—what assurance we can have that *his* water was free from easily oxidable matters?

As I have not put forth, however, any positive claims that boiling cannot really accomplish the work in question, I prefer to view the matter as now standing thus: Dr. Endemann has been the first to make the *positive* observation (as against my own previous merely *negative* results), that boiling can absolutely expel the air; and this important discovery (if verified), he has made by the use of the new method of testing proposed by me. Surely he cannot then consistently maintain the latter to be fallacious and uncertain, as he sets out to prove.

Still a word or two more under this first head. By "gas-analysis" it is to be presumed that Dr. Endemann means the determination of the gaseous contents of waters. Now, even with the positive and extreme sense which he has chosen to attach to the qualified sentence quoted above from my former article, I do not understand his alarm lest these methods should be "materially affected" by the adherence of immeasurably small "traces" of oxygen to water while boiling; the more especially as careful analysts do not rest satisfied with boiling, but use *exhaustion* in conjunction therewith.

2. *Carbonic Acid and Oxygen in Water.*—Dr. Endemann further asserts that my observation of the complete expulsion of dissolved oxygen by carbonic acid, either passed through or evolved in the liquid, is "nominal," and has no foundation.

As this is a most momentous matter, and involves

(as I pointed out to the Lyceum) theoretical considerations of vital importance in many sciences, I must say here—with emphasis—that my assertion was *positive*, and is now reiterated in the most positive manner. Dr. Endemann's statements on this head are nearly all unverifiable by experiment, and those which are true do not affect the case. For example, it is true—in fact obvious without experiment, or suggestion from Dr. Endemann—that *free* carbonic acid will prevent the coloration of pyrogalline by free oxygen; but it is not true—after carbonic acid has been passed through or evolved in ordinary aerated waters, in a moderate current (for say three minutes), and pyrogalline then added—that the saturation of the CO_2 by a caustic alkali will cause coloration. The experiment is among the simplest possible, and any chemist may satisfy himself in a few minutes, as to the main question. I would but suggest to add the reagents used, say oxalic acid, carbonate of ammonia, sodic hydrate and pyrogalline,* in *solid* crystalline fragments (to avert introduction of dissolved oxygen). In tall narrow jars or test tubes, the column of carbonic acid gas above the liquid will protect it sufficiently long, and slender glass rods may even be used for stirring. These experiments are readily and strikingly exhibitable to an audience of any magnitude by daylight at least. A communication on the general subject, with new facts, will soon appear. Strictly, in a reply like this, to strictures on a previous communication, new experiments are not in place.

3. *The Quantitative Application.*—Dr. Endemann begins his speculations on this head with a mistake or inaccuracy, which could only be excusable on the ground that my specifications were inaccessible to him, a ground which, in a controversial paper, is not available to him. Had his memory served him correctly, he would have recalled the use of *ammonia* in many of the experimental illustrations of my Lyceum communication, in making alkaline the liquids to be tested; sodic carbonate solution being only in fact preferred, when available, because more readily preparable in comparative freedom from oxygen. Yet it must clearly be inferred that he imputes to me the silliness of making a permanganate solution alkaline with carbonate of soda, and that the improvement of using ammonia therefor was an idea of his—Dr. Endemann's—by which he overcame the difficulty of the brown manganiferous precipitate. In trying to follow Dr. Endemann further in his criticism, I confess myself puzzled. I have been obliged to resort to the conclusion that he thinks the only possible way of valuing a solution of permanganate for this use, that is, of arriving at its equivalent in dissolved oxygen, would be by *calculation* of its theoretical content of oxygen; but this would argue a sad forgetfulness of the resources of volumetric analysis, and of working principles now familiarly applied in all laboratories by schoolboys. It is, for example, as if, in the determination of iron volumetrically by permanganate, we were to value the latter by calculation, instead of titrating it with a normal solution of iron. In view of the complex and obscure reactions Dr. Endemann fears, why should we not, in the first instance, directly titrate the permanganate with an artificially aerated water whose content of free oxygen is independently determined by the ordinary method of exhaustion by ebullition, together with the mercurial pump? Particularly, as some *modus operandi* equivalent to this is indispensable, in any case, to the final *establishment* of any method. The method for free oxygen recently proposed by Schutzenberger and Girardin—with "hydrosulphite of soda," cuprammonic sulphate, and indigo—has been largely tested and verified by comparative experiments in this way, by these chemists, as also in part by Professor William Ripley Nichols, of Boston.

Whenever I shall feel ready to place before the public my methods, in forms which I deem sufficiently substantiated, I shall beg leave to do so; and it will be time for chemists to decide whether or no to adopt them, when I shall have stated exactly what they are; which Dr. Endemann, I must submit, has too hastily assumed that he already knows sufficiently well. Regarding Dr. Endemann's cheerful "confidence that he (I) will fail in satisfying chemists," while I should of course be presumptuous in claiming that I am so sure of satisfying them, I surely am not so, in declining to participate in the *prophetic* confidence of that gentleman, in my utter and certain failure to establish a reliable quantitative method.

Respectfully,

Henry Wurtz.

Private Laboratory; 12 Hudson Terrace,
Hoboken, N. J., June 18, 1874.

* *Pyrogalline*, it may be desirable that I should note, is a name first used, I believe, by Bloxam, which I adopt because I consider, with him, pyrogallic *acid* to be a misnomer. I observe that some European Chemists have now dropped the "acid," but call it *pyrogallol* (classing it as a phenol). I might take the opportunity also to add that in the experiments with CO_2, a light *rosy* tinge may *sometimes* appear as a reaction, indicating oxygen still adherent, though in traces almost infinitesimal. It is scarce necessary that I suggest that *blank* parallel experiments should always be made, that is, comparative tests of the same water, without previous treatment with CO_2.
H. W.

1774.—CENTENNIAL OF CHEMISTRY.—1874.

To the Chemists of America:—

The year 1774 was rendered memorable by the discovery of oxygen by Joseph Priestley, by researches on chlorine by Scheele, and by important investigations undertaken by Lavoisier, which eventually led to the overthrow of the phlogistic hypothesis; the most important link in the chain having been contributed on the first of August, 1774, by Dr. Priestley.

The one hundredth anniversary of Priestley's brilliant discovery, now drawing rapidly near, is worthy of a commemorative ceremonial; and the fact, that this illustrious man spent the last years of his fruitful life in this country, renders the recognition of his work by American chemists peculiarly appropriate.

A reunion of American chemists for mutual exchange of ideas and observations would, it is believed,

foster a feeling of fraternity among us, and is considered by the undersigned eminently desirable. The approaching centennial affords a fitting occasion for such a gathering. We therefore invite the chemists of America to meet at Northumberland, Pennsylvania, where Priestley lies entombed, on the 31st of July, 1874, to elaborate by appropriate exercises this memorable epoch in the history of chemistry. Signed,

George F. Barker, University of Pennsylvania, Philadelphia, Pennsylvania.
Frederick A. P. Barnard, Columbia College, New York.
James C. Booth, United States Mint, Philadelphia, Pennsylvania.
George J. Brush, Sheffield Scientific School of Yale College, New Haven, Connecticut.
George C. Caldwell, Cornell University, Ithaca, New York.
Charles F. Chandler, School of Mines, Columbia College, New York.
William H. Chandler, Lehigh University, Bethlehem, Pennsylvania.
Josiah P. Cooke, Jr., Harvard University, Cambridge, Massachusetts.
Henry H. Croft, University College, Toronto, Canada.
Silas H. Douglas, University of Michigan, Ann Arbor, Michigan.
Henry Draper, University of the City of New York.
John C. Draper, College of the City of New York.
John W. Draper, University of the City of New York
Frederick A. Genth, University of Pennsylvania, Philadelphia, Pennsylvania.
Wolcott Gibbs, Harvard University, Cambridge, Massachusetts.
Charles A. Goessmann, Massachusetts Agricultural College, Amherst, Massachusetts.
S. Dana Hayes, State Assayer, Boston, Massachusetts.
Benjamin S. Hedrick, Patent Office, Washington, D. C.
Joseph Henry, Smithsonian Institution, Washington, D. C.
Eugene W. Hilgard, University of Michigan, Ann Arbor, Michigan.
Eben N. Horsford, Cambridge, Massachusetts.
T. Sterry Hunt, Massachusetts Institute of Technology, Boston, Massachusetts.
Samuel W. Johnson, Sheffield Scientific School of Yale College, New Haven, Connecticut.
Charles A. Joy, Columbia College, New York.
H. L. Kendrick, United States Military Academy, West Point, New York.
Albert R. Leeds, Stevens Institute of Technology, Hoboken, New Jersey.
Abram Litton, St. Louis Medical College, St. Louis, Missouri.
John W. Mallet, University of Virginia, Virginia.
Henry Morton, Stevens Institute of Technology, Hoboken, New Jersey.
Henry B. Nason, Rensselaer Polytechnic Institute, Troy, New York.
John M. Ordway, Massachusetts Institute of Technology, Boston, Massachusetts.
Ira Remsen, Williams College, Williamstown, Massachusetts.
Robert E. Rogers, University of Pennsylvania, Philadelphia, Pennsylvania.
Charles A. Seeley, New York City.
Benjamin Silliman, Yale College, New Haven, Connecticut.
J. Lawrence Smith, Louisville, Kentucky.
Henry Wurtz, Hoboken, New Jersey.

Communications should be sent to

H. Carrington Bolton,
Chairman of the General Committee,
School of Mines, Columbia College, New York.

Circular from the General Committee.

Northumberland is situated at the junction of the North and West Branches of the Susquehanna River, about sixty miles north of Harrisburg. The scenery in this region, always picturesque, is at this point exceedingly beautiful, and those visiting Northumberland will be fully repaid by the beauties of Nature alone. A short distance from the town, in a hillside cemetery, charmingly located, lie the remains of Joseph Priestley; the house he built, and in which he died, is in perfect preservation; many relics of him are found in the town; here, too, dwell his descendants, who honor and revere his name. These and other considerations influenced a majority of the committee to call the meeting at Northumberland; here, then, let those gather who are willing to pay a tribute to the memory of the good and great man who laid the corner-stone of chemical science.

The memorial exercises have not been definitely arranged; but it is expected that they will include—

I. An Address by Professor Joseph Henry.
II. A Sketch of the Life and Labors of Joseph Priestley, by Professor Henry H. Croft.
III. A Review of the Century's Progress in Theoretical Chemistry, by Professor T. Sterry Hunt.
IV. A Review of the Century's Progress in Industrial Chemistry, by Professor J. Lawrence Smith.
V. An Essay on American Contributions to Chemistry, by Professor Benjamin Silliman.

Detailed programmes of the exercises will be in readiness for distribution at the meeting.

In order to add to the interest of the occasion, a Loan Exhibition will take place during the meeting for displaying apparatus, books, manuscripts, etc., belonging to Dr. Priestley, or other objects illustrating the history of chemistry. Gentlemen receiving this circular are earnestly requested to contribute anything in their possession appropriate to this Loan Exhibition.

In order to assist the Local Committee in arranging accommodations, those planning to attend the meeting are requested to send their names to Dr. Robert B. McCay, Secretary of the Local Committee, Northumberland, Pennsylvania; also to indicate whether accompanied by ladies, and how many.

Gentlemen should reach Northumberland on the

evening of July 30th; on arriving they are requested to report to Dr. Robert B. McCay, at the headquarters of the Local Committee.

Hotel accommodations in Northumberland, and Sunbury, two miles distant, are ample. Price, two dollars per day. A large number will also be entertained by the hospitable residents of Northumberland.

Northumberland lies on the Northern Central Railroad of Pennsylvania, which connects at Elmira with the Erie Railroad, and at Harrisburg with the Pennsylvania Central Railroad; it is, therefore, accessible from all points. Trains leave New York at 9 A.M., by the New Jersey Central, via Easton and Reading, and at 9.30 A.M., by the Pennsylvania Railroad, via Philadelphia; both connecting at Harrisburg with a train reaching Northumberland at 7.10 P.M. It may also be reached from the east by the Delaware, Lackawana, and Western Railroad, via Scranton. Those preferring night travel will find trains to accommodate them.

☞ Parties travelling from the east can obtain excursion tickets on presentation of this circular at the offices of the Pennsylvania Railroad Company, 526 Broadway, New York. The tickets will be issued at the reduced price of $8 50 for the round trip, and will be good from July 25th to August 10th. The price of round-trip tickets from Philadelphia will be $6 55.

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DETERMINATION OF PHOSPHORIC ACID IN SOUTH CAROLINA AND SIMILAR PHOSPHATES.

BY DR. CHARLES U. SHEPARD, JR.

1. Weigh out, in a small porcelain evaporating-basin, from 1·5 to two grammes of the finely pulverized phosphate; add sufficient water to moisten the powder, and nearly to cover it; treat with about 10 c.c.m. concentrated and chem. pure hydrochloric acid; allow the effervescence to subside *before* the application of any heat. Then evaporate to complete dryness, on a sand or water-bath; remove the dish from the bath, and allow to cool. Add cautiously about 10 c.c.m. concentrated and chem. pure nitric acid, taking care to leave no portion of the residue on evaporation above the level of the acid in the dish. This may be accomplished by carefully washing such particles from the side (after they have become moistened by the acid in the dish) with a very few drops of water. Allow the escape of chlorine and other gases to complete itself before replacing the basin on the bath. Evaporate to complete dryness. Add, cautiously, quite dilute (chem. p.) nitric acid: warm for a half-hour; filter, using warm and hot wash-water, until the acid reaction has entirely disappeared.

2. The solution, measuring 200 to 300 c.c.m., is halved. To one-half, in a beaker glass, are added 20 c.c.m. conc. and chem. p. nitric acid and, after stirring, 200 c.c.m. (usually) of 5 p. c. molybdate of ammonia solution.* This is well stirred with a glass-rod, and then warmed for an hour or two at about 40° C., on the sand-bath. After standing for several hours, generally over night, it is filtered, and the precipitate well washed with about 75 c.c.m. of a 3 p. c. solution of molybdate of ammonia in nitric acid.† (If any precipitate subsequently appears in the filtrate, it is also filtered and washed, and, after treatment as below stated, its solution added to that of the first.)

3. The precipitate in the beaker and on the filter is dissolved in dilute (3 to 5 p. c.) ammoniacal water; the subsequent wash-water being still more dilute (2 p. c.). The filtrate is treated with hydrochloric acid until the precipitate that forms on the addition of the acid is just taken up, on active stirring, into solution. It is allowed to stand for several hours in a cool place.

4. The solution is filtered through the last-used filter, and before any washing is attempted, about 15 c.c.m. of a solution of chloride of magnesium‡ is carefully added. Then, after allowing the *crystalline* precipitate of the phosphate of magnesia and ammonia to form, which requires at least fifteen minutes, the filter is thoroughly washed with about one-half as much ammoniacal water as the volume of the liquid, care being

* *Five per cent. Molybdate of Ammoniac Solution, for precipitating.*—Take 100 grammes molybdic acid, chem. pure; dissolve in dilute ammoniacal water, avoiding any excess of ammonia; filter after allowing to stand several hours, and dilute to 2000 c.c.m.

† *Three per cent. Solution of Molybdate of Ammonia in Nitric Acid, for washing.*—Dissolve 20 grammes molybdic acid in as little ammoniacal water as possible, dilute to 200 c.c.m. with water, and pour the same, slowly and with frequent shaking, into 400 grammes conc. and chem. p. nitric acid; allow to stand for several days, then filter.

‡ *Chloride of Magnesium Mixture.*—Take 34·2 grammes chem. p. carbonate of magnesia, dissolve in sufficient (dilute) chem. p. hydrochloric acid, and add the solution to a mixture of 100 grammes chloride of ammonium, 400 grammes ammoniacal water, spec. grav. 0·96, and sufficient water to bring the whole to 1500 c.c.m.; allow to stand for several days, then filter.

taken that the amount of ammonia in the whole shall approximate 2·5 p. c.

5. After standing for several hours, generally over night, it is filtered through a double filter, and washed with 2·5 p. c. ammoniacal water, until there is no further reaction for chlorine.* The rest of the process is that usually followed.

No allowance is made for any supposed solubility of the phosphate of magnesia and ammonia-precipitate in the ammoniacal water, containing, as it does, magnesia mixture. (*Kissel.*)

CHLORALUM AND ITS PREPARATIONS AS DISINFECTANTS.

BY PROF. D. N. FLECK,† DRESDEN.

Translated from the "Vierteljahresschrift für practische Pharmacie," vol. xxi., No. 2, by Charles M. Rolker.

The chemical office of the Dresden board of health, instituted in the beginning of the last century, received, among other articles, samples of the disinfectants, which have been set into circulation by the London Chloralum Company, for the purpose of ascertaining exactly the composition of the same and to determine its real value. Considering the ostentatious display with which the Chloralum Company has started its business, and the activity it has manifested so far, persons were led to take the article either as of superior quality or as a dubious issue. The suspicion against the Company with regard to the latter opinion has been supported by several indications. The advertisement and recommendation of chloralum resembles very much the so-often read praises of chlorhydrate, originating likewise from England, which preparation shall be applicable as a narcotic in surgical operations; and may not this lead to the assumption of an intimate connection between the two? And yet chloralum and chlorhydrate are two entirely different substances. Besides the proper circulars for the disinfectants, which show medical and scientific (?) recommendations and attests, and of which several accompany each sample, a monthly "Chloralum Review," a sanitary journal, is published in which many direct, and even as many indirect praises are being sung to the unsurpassed chloralum.

The most popular papers and journals of Germany are the advertising means of the Chloralum Company.

It seems high time that an impartial decision shall be given of the chloralum industry and its products; as such unprejudiced judgment may be taken the opinion of the government chemical office of the board of health.

The Chloralum Company recommends as disinfectant:

1. The chloralum, indorsed by chemistry and physics, the surest, odorless, and most unpoisonous disinfectant, being rapidly introduced in Great Britain, may be applied for the disinfection of water-closets and garbage, stables, slaughter houses and gutters, for external and internal use in case of sore throat, diphtheria, scarlet fever, smallpox, etc.

The liquid contents of a neatly labelled vessel, weighing 637 grms., having the volume of a half litre, and costing 15 sgr.,* were subjected to chemical analysis.

The liquid contains:—

83·32	%	water.
0·15	"	chloride of lead.
0·10	"	chloride of copper.
13·90	"	chloride of aluminium.
0·42	"	chloride of iron.
3.11	"	chloride of calcium with gypsum.
100·00		

2. Chloralum-powder, as an absorbent of organic impurities, mixed with wheaten flour, as an antiseptic and astringent, may also be applied as a disinfectant for railroad cars, vessels, privies, stables, gutters, etc. etc.

A tin box, likewise neatly labelled and containing a white powder of 370 grms. in weight, and costing 5 sgr.,† was received for analysis. The same contained:—

0·72	%	chloride of arsenic.
0·55	"	chloride of lead.
0·37	"	chloride of copper.
52·43	"	chloride of aluminium.
1·55	"	chloride of iron.
11·51	"	chloride of calcium.
0·72	"	gypsum.
32·15	"	clay and silicic acid.
100.00		

3. "Chloralum-wool and wadding," recommended as an air filter, as a styptic and antiseptic for fresh suppurating wounds, for cancer, as a disinfectant for coffins and corpses.

For analysis was received a bag properly labelled and of water-proof texture, containing 35 grms. of well saturated and dried wadding [with 1·73 grms. solid chloralum, or 9·80 grms. liquid chloralum], the price of which is 20 sgr.‡ These analytical results no longer leave a doubt with regard to the origin, manufacture, and real value of the chloralum preparations. The manufacture is the following:—

A calcareous and slightly ferruginous clay is treated with crude fuming hydrochloric acid, and dissolved as much as possible. The concentrated liquid, after letting the undissolved particles settle, is decanted, bottled, and sold as "chloralum." [It has its name from the chloride of aluminium it contains.] The undissolved residue, just as it is left, is dried in leaden pans, and this furnishes the "chloralum powder."

In the above chloralum liquid, wool or wadding is immersed, saturated with it, pressed and dried, and this gives the "chloralum wool and wadding." The impurities of arsenic, lead, and copper are caused by the impurity of the solvent, hydrochloric acid, or of the apparatus in which the dissolving of the clay takes place. The real value of the contents of the chloralum bottles cannot be set above 2 sgr.,§ while it is being sold for 15 sgr.* The value of the chloralum powder sold in tin boxes for 5 sgr. cannot be fixed higher than 1 sgr.,‖ it being simply a dried waste product.

* *Table of Specific Gravities and Strength of Ammoniacal Water at* 13·9° *C.* (Bloxam's Chemistry, p 115).

Spec. Grav.		Per cent. of Ammonia by Weight.
0·8844	=	36
0·8976	=	30
0·9106	=	25
0·9251	=	20
0·9414	=	15
0·9593	=	10
0·979	=	5

† Industrie Blatter, 1872, No. 4.

* 15 sgr. = 35½ c. gold.
‡ 20 sgr. = 48 c. gold.
‖ 1 sgr. 2·4 c gold.
† 5 sgr. = 12 c. gold.
§ 2 sgr. = 4·8 c. gold.

The chloralum wadding, sold at 20 sgr., has for the most a value of ½ sgr.*

A solution of 10 grms. of sulphate of alumina in 1 pound well water replaces in all cases the above preparations, in which all constituents, except the chloride of aluminium, are impurities, viz., poison, and it costs not above 1 sgr.

To fix the value of chloralum as a disinfectant, equal volumes of sewer liquid were treated with chloride of lime, alum, sulphate of iron, chloralum, caustic lime, and chloride of magnesium, and the clear supernatant liquid tested with alkaline silver solution for its percentage of putrefying matter. The useful effect of these disinfectants and clarifiers is represented by the following figures:—

Chloride of lime disinfects	100·0	%	putrefying	matter.
Caustic lime	"	84·6	"	"	"
Alum	"	80·4	"	"	"
Sulphate of iron	"	76·7	"	"	"
Chloralum	"	74·0	"	"	"
Chloride of magnesium	"	57·1	"	"	"

The disinfecting and clarifying effect of chloralum is, as we see, inferior to those of alum or sulphate of alumina and of the green vitriol, both of which are considerably cheaper than the chloralum.

If we summarize the data given with regard to value and composition of the chloralum preparations, we shall have—

1. Chloralum preparations are entirely different from chlorhydrate; they are chiefly mixtures of chloride of aluminium.

2. The chloralum preparations contain the chlorides of lead, copper, and arsenic, which render its application dangerous, especially as internal medicaments, or as astringents for fresh and suppurating wounds.

3. The price of chloralum preparations is out of proportion regarding composition and useful effect. Where, as in case of the liquid chloralum, a net profit of at least 700 per cent., or, as in case of the wadding, a clear profit of at least 4000 per cent., can be easily calculated, the limits of sound and solid business are transgressed.

4. According to the above results, chloralum and the preparations thereof belong to that class of unworthy secret preparations, which the public should be warned decidedly against buying, as the common health as well as the material interest of the general public require so doing.

* ½ sgr. = 1·2 c. gold.

THE GERM THEORY OF DISEASE.

An Address delivered before the American Public Health Association, at their Meeting in New York, October, 1873.

BY PRESIDENT F. A. P. BARNARD, LL.D.,

Of Columbia College.

No more striking evidence can be adduced of the intellectual advancement characteristic of modern times, than the general recognition among men of the universal reign of law. It is true that this general recognition has not yet become quite universal. There are not wanting many, even in our enlightened age, to whom the advent of a comet still brings feelings of dismay, and in whose belief the wind literally bloweth where it listeth, every day. The belief in lucky and unlucky days has by no means disappeared, and among even the well educated there are yet some who would not willingly put to sea on the brightest Friday morning that ever shone. It is difficult to disabuse the mind of impressions which almost inevitably find a place there in the infancy of individuals and of peoples. Every event, of which the causes are obscure, is naturally attributed, by the ignorant or inexperienced, either to blind chance or to the purposed interference of some supernatural power; and such is the strength of the imagination that the feeling often survives long after reason has exploded the error.

There is no class of natural phenomena which the men of all time have been disposed to look upon as being more completely exempt from the dominion of law, than those which concern sickness and health. The illness of an individual appears always to have been esteemed an event entirely fortuitous, which no human prescience could anticipate, and no human precaution could avert; and the simultaneous sickening and death of multitudes has more frequently been regarded as an evidence of divine displeasure, directly interfering with the usual order of nature, than as a grave and interesting phenomenon to be patiently investigated and rationally explained. The truth is, nevertheless, that the laws of health and of disease in living organisms are as fixed and invariable as, in abstract science, are those of mathematics. The difference lies in the greater difficulty of their discovery. This is well illustrated in the history of the subject which I have ventured, with a presumption which in this presence may seem like temerity, to select as the theme of my remarks this evening.

The germ theory of disease is not, as is commonly supposed, a theory which has originated in very recent years. More than two hundred years ago it was brought forward, at least as an hypothesis, by the celebrated Father Kircher, in his *Scrutinium Physico-Medicum contagiosæ luis quæ pestis dicitur*, to account for the infectious propagation of the plague. However plausible this theory might at that time have seemed, it could then, nevertheless, claim no higher rank than that of a bare hypothesis; and it has only been in times comparatively recent that observation has brought to light a sufficient number of facts apparently favoring it to justify our advancing it in the arena of scientific discussion to the higher dignity of a theory.

GENERAL PRINCIPLES.

Before proceeding to consider the evidences bearing on the truth of this theory, for or against, a few observations of a general nature may properly here find place. No living organism enjoys an existence of unlimited duration. Every such organism, under favorable circumstances, passes through three distinct stages, which are those of growth, vigorous maturity, and decline. The organism commences as a germ, and ends in dissolution and disintegration. Since the laws of life, as well as those of physics, are fixed and definite, there is reason to believe that all organisms of the same species, if placed in conditions equally favorable to their development, would be equally long lived; yet, in point of fact, those which pass through the regular stages constituting their normal life are comparatively few. In the large majority, the vital functions are, earlier or later, more or less disturbed, if not arrested, by an endless variety of causes tending to produce disease and premature death. In the human race, life is often

shortened by ignorant or wilful disregard of the conditions necessary to the preservation of health. Accident, also, often exposes individuals to deleterious influences. Thus, in many cases, diseases arise from exposure to extremes of temperature, or from excesses in eating and drinking, persisted in until the organs of digestion become debilitated and fail to fulfil their proper functions. But besides these causes of disease, which may be classed under the head of "injurious conditions," there are other influences directly morbific, which, whenever they come into play, cut short the duration of life. Poisons belong to this class, but the effects of these are felt only in occasional and accidental instances. Other noxious influences, of which the pernicious consequences are more widely spread, are those which produce the diseases called zymotic. Such are malaria, contagion, and infection, instrumentalities to which are owing the widespread ravages of epidemics.

It may be remarked that there are many cases of disease in which the cause is not traceable directly to any of the sources above mentioned, but in which the disease has been transmitted by inheritance from a parent similarly affected. In such cases there is nevertheless every reason to believe that the disease in its first appearance was produced in a healthy organism by causes belonging to one or the other of the classes above named.

The diseases, which it is the object of the present paper to consider, are only those which belong to the epidemic or contagious class.

THE EPIDEMIC OR CONTAGIOUS CLASS OF DISEASES.

No subject has occupied more the careful attention of physicians, or has been a subject of more elaborate observation and experiment, or has led to more marked differences of opinion or more animated controversy, than that of the nature of the influences by which these diseases are transmitted from individual to individual. That many epidemics arise from peculiar conditions of the atmosphere, not in the least as yet understood, can hardly be doubted; and in this case the influence which excites disease simultaneously in many is not dissimilar to that by which contagious diseases are transmitted from individual to individual. Confining ourselves, however, for the moment, to this latter mode of transmission, it may be observed that two theories distinctly opposed to each other have long been held on the subject, each of them counting in its advocacy authorities of the very highest character. These may be distinguished as the chemical theory of infection and the germ theory. The chemical theory is founded on a presumed analogy between the propagation of disease in living organisms and the process of fermentation in certain forms of organic matter without life. This theory assumes a ferment to be an organized substance in a certain state of decay, which possesses the property of exciting the same decay in other organic substances with which it is in contact. Applying this theory to disease, it supposes that infection is communicated by the instrumentality of particles thrown from the person, or from substances proceeding from the person diseased, and borne by the air to other persons in full health, on whom they excite, probably by contact with the membranous linings of the lungs, the same diseased condition which exists in the patient. The opposing theory presumes that the diseased person is suffering from an invasion of his system by microscopic algoid or fungoid vegetative forms having the property of rapid self-multiplication, and that the spores which proceed from these fungi or the cells of the algæ are wafted in like manner by the air from person to person, penetrating the systems of the healthy, and establishing new colonies to generate disease in them.

EVIDENCES FAVORABLE TO THE GERM THEORY.

A prima facie evidence, which, so far as it goes, is favorable to the germ theory, is found in the well-known fact that all the forms of cryptogamic vegetation are propagated by spores, which they shed freely abroad in all directions; and that these are borne in infinite numbers through the atmosphere, which they pervade near the surface of the earth in all places. The fact of their universal presence is made manifest by the promptness with which fungoid growths spring up in all circumstances in which the conditions favor their development. Such conditions embrace a congenial temperature, and the presence of some organic substance suitable to serve as a nidus, and furnish for them their proper food. There are peculiar forms of fungus which appear on particular forms of organism and nowhere else. Thus the hoofs of dead horses are overspread, when exposed at a moderate temperature to moisture, with a vigorous growth which is seen in no other situation, and some of the larger plants are infested by their peculiar fungi.

This constant appearance of minute forms of vegetable life could not take place so invariably in all varying situations were not the spores of the fungi continually present in the air throughout its whole extent. We know that the numbers of these spores which all fungi produce are incalculable. The larger fungi give us evidence of this. The spores of a single puff-ball have been estimated to be more numerous than the entire human population of the globe. It is true that to ordinary observation the presence of foreign matters in the atmosphere is not perceptible, except when such foreign matters take the gross form of clouds of smoke or dust; but particles of smoke or dust, and in general of all inorganic substances, are so heavy that they soon subside; yet when the air is thus left apparently free from all foreign admixture, it is demonstrably full of organic particles so extremely light as not to subside for many hours or even days of perfect rest. The chemist, it is true, is unable to detect them by his tests, delicate as they are; for being organic, and composed in general of but two or three elements—which elements are in great part those of the atmosphere itself—they produce no distinctive reactions under the ordinary processes of analysis. But there is a mode of analysis much more delicate than even that of the chemist. It is that which has been applied incidentally to this question by Prof. Tyndall, in his interesting investigation into the chemical effects of light upon vapors. Prof. Tyndall discovered that there are many substances of great volatility which, when in the state of vapor, are easily decomposed by light. He found that a perfectly transparent vapor, like steam, when traversed by a luminous beam, is absolutely invisible; while we all know that if we admit a beam of sunlight into a darkened room, through an aperture in the shutter, the path of the beam through the apartment is as distinctly marked as if it were a solid bar. That this visibility of a beam of light in the air is not owing to the power of the aerial particles themselves to reflect light is demonstrated by him by proofs entirely conclusive. A beam of light from an electric lamp was made in his experiments to pass through a large glass tube closed at both ends by plates of glass cemented on. No light

was permitted to escape into the room; and, accordingly, when the tube was exhausted of air altogether, and no light from its interior was reflected to the eye, it was perfectly invisible. But if the air of the room were allowed to re-enter it, it immediately became brilliantly luminous, as in the case of a sunbeam admitted through the window shutter. If, however, the air before being admitted into the empty tube had been passed through a red-hot tube of platinum, the tube thus filled remained as completely invisible as when it was a perfect vacuum. This experiment, which is but one of many employed by Prof. Tyndall to demonstrate the same proposition, shows that not only the air is full of foreign matters, but that these foreign matters are organic; for, were they not so, they could not be destroyed by fire. He proved also that these particles are so numerous that they cannot be entirely arrested by passing the air through the most energetic chemical reagents, as sulphuric acid, caustic potash, and the like; but, that, though these substances arrested a large portion of the organisms, they allowed still not a few to escape. He showed, however, that a filter of rather closely compacted cotton will shut off entirely, or almost entirely, the organic matters which the air contains; and he showed, finally, that absolute rest for a long period of time will cause these particles completely to subside. Thus a large flask which had been standing in the store-room was found to be, as he expressed it, "optically empty;" that is to say, the rays of light passed through it without showing any more trace of their path than if it had been a vacuum. He also experimented to ascertain how long a time would be required to free the air by subsidence of its suspended particles in a space completely closed, and for this purpose he constructed such a closed space, cubical in form and several feet in lineal dimensions, glazed so as to permit him to pass through it a beam of light, and to observe the path of the beam. This small apartment was made absolutely air-tight, and left to itself. On each succeeding day the brilliancy of the transmitted beam grew less and less, and at length, at the end of a week, it could no longer be perceived at all. The apartment was optically empty.

THE AIR FILLED WITH ORGANIC MATTER.

These experiments, and others no less interesting, by Prof. Tyndall, thus prove, in the most conclusive manner, that the ordinary air at the surface of the earth is always completely filled with particles of organic matter. It is not necessary to suppose that all these particles are living germs of vegetable or animal organisms, but when we see how constantly such organisms make their appearance wherever the conditions favor germination, it is impossible to doubt that a vast many of them have this character; and that these are the source of those growths of minute cryptogams which thus seem to spring up spontaneously. There is no other mode of accounting for such growths, except to suppose that they are actually spontaneous; and accordingly the view has been taken by some physiologists, perhaps I should say by many, that the true mode of accounting for the appearance of microscopic forms of life, is to suppose that they originate without organic antecedents, or, as they express it, *de novo*.

THE ORIGIN OF LIFE.

No question at the present day is more sharply debated than that which relates to the origin of life. There is no subject which has been pursued experimentally with more zeal, more earnest solicitude to reach the truth, or with more singularly discordant results than this. The notion of spontaneous generation is not, by any means, of modern origin. It has been entertained by naturalists in every age since the dawn of scientific history. But the earlier naturalists, Aristotle and Lucretius, for instance, conceived that organisms of a high order of complexity, such as insects, or fishes, or reptiles, might be directly produced out of the moist earth softened by showers, or out of the slime and mud of rivers; whereas those of our time have long since abandoned any such extravagant notions, and confine themselves to the assertion that life in its spontaneous origin is manifested only under the simplest forms.

The latest example of an hypothesis resembling the ancient is found in the argument presented in a work entitled *Vestiges of Creation*, which appeared about thirty years ago, in which the experiments of Mr. Andrew Crosse upon electric currents of low intensity directed for a long time through a solution of inorganic salt were supposed to have produced an insect of the Acarus family, such an insect having actually made its appearance during the course of the experiment. But this result has long since been recognized to have been merely accidental, and probably owing to the presence of ova of the insect introduced in some unexplained way into the apparatus. The modern advocates of the theory of spontaneous generation hold, however, or at least most of them hold, only to the certainty of the spontaneous appearance of organisms of a very low type, called bacteria, vibriones, and monads, organisms familiar to the microscopist, and which are sure to make their appearance in every putrefying organic infusion.

MODERN CONTROVERSIES ON THE SUBJECT.

Less than three centuries ago the belief here spoken of, that living things may originate without eggs, or germs, or living parents, from which to proceed, may be said to have been universal in Europe. Of the truth of this belief there was supposed to be visible evidence in the invariable occurrence of maggots in putrefying flesh. Curiously enough, scriptural authority was cited in proof of this view, and the Old Testament story of the bees found by Samson in the carcass of the dead lion, was presumed to confirm it. The doctrine was therefore held as matter of faith, and those who first assailed it were naturally accused of impiety and irreverence. Prominent and perhaps first among these was Francis Redi, an Italian philosopher, scholar, and poet, born in 1626. He presented a conclusive disproof of the spontaneous generation of maggots in putrefying flesh, by simply inclosing in open-mouthed jars covered with gauze, pieces of flesh still sound, and leaving them in the sun to putrefy. Putrefaction occurred as before, but no maggots made their appearance. The maggots, nevertheless, did appear on the gauze, and a little observation made their origin manifest. The flies, of which they are the progeny in the larva state, being attracted by the odor of the flesh, but unable to reach it, laid their eggs upon the covering of the jar, and out of these the larvæ were presently developed. Having demonstrated the falsity of the popular belief on this subject in a case so conspicuous, Redi naturally generalized his conclusion, and took the ground that no living thing comes into existence without deriving its life from something previously living. He did not say, as it has been said later, "*Omne vivum ex ovo*," but "*Omne vivum ex vivo*." He still believed that out of a living plant

may arise a living animal, as the insect within the gall of the oak, or the worm within the fruit which presents no external puncture. His doctrine was, therefore, that which Huxley has named *Biogenesis*, in contradistinction to spontaneous generation, called by him *Abiogenesis*, and by Bastian, *Archegenesis*. But Archegenesis had been put aside only to return again under a new form. Among the earliest revelations of the microscope was the remarkable fact that whenever a dead organic substance is infused in water myriads of minute creatures presently make their appearance in the infusion, all possessing most extraordinary and many of them very varied powers of reproduction. They multiply by means of *ova*, by means of buds, or gemmation, and by means of self-division, or fissuration. All this was strongly favorable to the doctrine of Biogenesis. Where so many means of reproduction existed, every one of them so effectual and sufficient, to provide that the same forms of life should be produced without any organic antecedents, seemed "wasteful and ridiculous excess." This view, however, met here and there with a dissentient. About a century and a quarter ago John Turberville Needham, an English naturalist, resorted to an experiment which, with various modifications, has been since, many hundreds and possibly many thousands of times repeated, with the view thoroughly to test the question whether, in its application to infusorial life, the doctrine of Biogenesis is universally true. He prepared an infusion, thoroughly boiled it in a flask, corked it tight, sealed the cork with mastic, and covered the whole with hot ashes, designing to destroy by heat any germs which might be in the infusion, in the substance infused, or in the air above the liquid in the flask. After some days or weeks, he found that, notwithstanding all these precautions, living organisms did make their appearance in the flask, precisely such as in freely exposed infusions habitually appeared earlier. This experiment was immediately repeated by Spallanzani, an Italian ecclesiastic and naturalist; but Spallanzani, instead of corking his flask, and cementing his corks, sealed the vessels by fusing the glass; and having thus completely cut off communication with the outward air, kept them at the boiling temperature for three-quarters of an hour. No life appeared in the infusions of Spallanzani, and the doctrine of Biogenesis was again apparently triumphant.

The question was, however, not yet universally admitted to be settled. Dissentients made themselves heard from time to time, among them Gleichen, Otho Müller, and Treviranus; the latter of whom pointed out the significant fact that, while the species of infusorial animals found in infusions of the same kind were constantly the same, those which appeared in different effusions were not so. Early in the present century the celebrated naturalist, Lamarck, ranged himself on the side of spontaneous generation. Oken took the same view, and subsequently Bory St. Vincent, J. Müller, Dujardin, Burdach, and Pineau; while on the opposite side appeared, among others, Schwann, Schultze, and Ehrenberg. The experiments of Schultze and Schwann were remarkable. They were undertaken for the purpose of testing the accuracy of those of Spallanzani. Since those experiments had been made, the importance of air, or of oxygen, one of its constituents, to the maintenance of animal life had been discovered, and doubts had arisen whether, in those experiments, the air had not been rendered unfit for the support of life by the operations to which it had been subjected. In repeating the experiments, Schultze admitted to the flasks, after boiling the infusions, only such air as had been passed through concentrated sulphuric acid; and Schwann only such as had been conducted through red hot tubes. No animalcules made their appearance; and these results, reached as long ago as 1836 and 1837, were regarded by the great body of naturalists as finally settling the question.

RECENT REVIVAL OF THE DISCUSSION.

The controversy, however, after resting for twenty years, was revived and prosecuted with even more animation than before, by M. Pouchet, in the first instance, on the side of spontaneous generation, and M. Pasteur, on that of biogenesis; but more recently by many naturalists of distinction, among whom may be named Dr. Jeffries Wyman, of our own country, whose experimental researches tend rather to the support of the archegenetic theory, and Prof. Huxley, of London, whose opinion, given on a survey of the whole history of the controversy, and expressed before the British Association in 1870, is very decidedly the other way. While the controversy was between M. Pasteur and M. Pouchet, there can be no doubt that, in the judgment of the world, the former had by far the best of the argument. His experiments, which were substantially repetitions of those of Needham and Spallanzani, but which were variously modified, so as to render his demonstrations in every possible way cumulative, seemed to have disposed of the doctrine of spontaneous generation effectually and forever. In multitudes of instances infusions hermetically sealed while boiling remained for indefinite periods of time free from all traces of organic life; while portions of the same infusions exposed side by side with these, but open to the air, were speedily swarming with animalcules. He found that even an unsealed flask, of which the neck had been stopped during the boiling only with a plug of cotton, closely pressed together, continued to be equally free from these organisms so long as the stopper remained in its place. This last experiment presented a rather curious resemblance to that of Redi, with his gauze-covered jar; for the cotton forming the plug was found, on a microscopic examination, to contain the germs which its presence had prevented from entering the flask. M. Pasteur finally found—and this result was long supposed to have furnished an unanswerable reply to all the arguments of the advocates of archegenesis—that flasks, containing infusions treated by boiling as before, required neither sealing nor stopping with cotton to prevent invasion of the contained liquids by these low forms of life; provided only that the necks of such flasks had been originally bent over, so as to direct their mouths downward. This result he had predicted as probable, holding, as he did, that the germs by which such infusions are repeopled, when the living embryos they may contain have been destroyed by heat, must necessarily subside into them from the air above.

The experiments of Wyman, Bastian, Cantoni, and others, more recent than those of Pasteur, have led to results singularly, and at present, we must say, unaccountably, at variance with his. Prof. Wyman found that *bacteria* will make their appearance in infusions which have not only been boiled before being sealed up, but which, after being sealed, have been kept at a boiling heat for many hours. He found, moreover, that these same organizations perish when exposed to a heat not over 134° Fahrenheit. Bastian, in a very extended series of experiments, has pushed the heat in the tubes containing his infusions as high as 300° Fahrenheit,

maintaining this high temperature, in some instances, not less than four hours; and has yet found that living forms do not fail subsequently to make their appearance in them. Such forms appear also, according to him, in solutions containing nothing of organic origin whatever, but composed entirely of certain salts of soda and ammonia; and he even affirms that in such solutions he has occasionally seen very remarkably fungi to present themselves with their full fructification, drawings of which he has given in his work, recently published, entitled *The Beginnings of Life*.

It seems to me that no one can rise from the perusal of the extraordinary book just mentioned without feeling that if it does not embrace and contain the conclusion of the whole matter, it is at least for the present unanswerable. It leaves us, nevertheless, still perplexed, perhaps more deeply perplexed than before; for it is impossible to understand how the results reached by so many naturalists, all in the first rank of scientific investigators, all conscientiously laboring to elicit the truth of this great question, should be, after all, so singularly discordant. And another weighty consideration adds to this perplexity. It is the existence of a practical refutation of the conclusions of the class of experimenters to which Dr. Bastian belongs, which is presented under our eyes every day on the grandest scale in the operations of one of the most important departments of modern industry. I cannot state this consideration better than in the words of Huxley: "There must," remarks this distinguished physiologist, "be some error about these experiments, because they are performed on an enormous scale every day with quite contrary results. Meats, fruits, vegetables, the very materials of the most fermentable and putrescible infusions, are preserved to the extent, I suppose I may say, of thousands of tons every year, by a method which is a mere application of Spallanzani's experiment. The matters to be preserved are well boiled in a tin case provided with a small hole, and this hole is soldered up when all the air in the case has been replaced by steam. By this method they may be kept for years without putrefying, fermenting, or getting mouldy." He argues—and the argument has a weight that must be felt—that there is no mode of explaining this universal and invariable result but the exclusion of germs from these cans. And in view of the marvellous discrepancy between the results on the small and the grand scale placed side by side, one can hardly repress the suspicion that if there be any such thing as spontaneous generation it is a thing which occurs only under rare and extraordinary conditions, which conditions Dr. Bastian has unintentionally succeeded in establishing, while as a matter of practical importance or daily interest it is as if it were not.

BEARING OF THE DOCTRINE ON THEORIES OF MENTAL LIFE.

There is a view of this question, however, which, though it may seem out of place here, I cannot forbear to mention. To the philosopher, the demonstration of the theory of spontaneous generation, should it ever be demonstrated beyond all possibility of doubt or cavil, cannot but be a matter of the deepest interest. But to the man who finds himself compelled to receive it, this interest, it seems to me, must be no less painful than it is deep. Nor is this the only theory which the investigators of our time are urging upon our attention, of which I feel compelled to make the same remark. There are at least two besides which impress me with a similar feeling, and the three together constitute a group which, though to a certain extent independent of each other, are likely in the end to stand or fall together. These are the doctrine of spontaneous generation, the doctrine of organic evolution, and the doctrine of the correlation of mental and physical forces. If these doctrines are true, the existence of an intelligence separate from organized matter is impossible, and the death of the human body is the death of the human soul. If these doctrines are true, the world becomes an enigma, no less to the theist than it always has been to the atheist. We are told, indeed, that the acceptance of these views need not shake our faith in the existence of an Almighty Creator. It is beautifully explained to us how they ought to give us more elevated and more worthy conceptions of the modes by which He works His will in the visible creation. We learn that our complex organisms are none the less the work of His hands because they have been evolved by an infinite series of changes from microscopic gemmules, and that these gemmules themselves have taken on their forms under the influence of the physical forces of light and heat and attraction acting on brute mineral matter. Rather it should seem we are a good deal more so. This kind of teaching is heard in our day even from the theologians. Those sentinels on the watch-towers of the faith, whose wont it has been for so many centuries to stand sturdily up in opposition to the science which was not, in any proper sense, at war with them, now, by a sudden and almost miraculous conversion, accept with cheerful countenances, and become in their turn the expounders and champions of the science which is. But while they find the mystery of the original creation thus satisfactorily cleared up in their minds, they seem to have taken very little thought as to what is going to come of the rest of their theology. It is indeed a grand conception which regards the Deity as conducting the work of His creation by means of those all-pervading influences which we call the forces of nature; but it leaves us profoundly at a loss to explain the wisdom or the benevolence which brings every day into life such myriads of sentient and intelligent beings only that they may perish on the morrow of their birth.

But this is not all. If these doctrines are true, all talk of creation or methods of creation becomes absurdity; for just as certainly as they are true, God himself is impossible. If intelligence presupposes a material organism, of which it is a mode of action, then God must be a material organism, or there is no God. But it is the law of all living organisms that they grow, mature, and perish; and since God cannot perish, He cannot be an organism.

But we are told it is unphilosophical in the pursuit of truth to concern ourselves about consequences. We should accept the truth with gladness, whatever it may be, and let consequences take care of themselves. To this canon I am willing to subscribe up to a certain point. But if, in my study of nature, I find the belief forced upon me that my own conscious spirit, as well as my animal life, is but a mere vapor, which appeareth for a little time and then vanisheth away forever, that is a truth which I cannot receive with gladness, and for which I shall never thank the science which has taught it me. Much as I love truth in the abstract, I love my hope of immortality still more; and if the final outcome of all the boasted discoveries of modern science is to disclose to men that they are more evanescent than the shadow of the swallow's wing upon the lake, it seems to me no better than a heartless mockery to talk of the countless treasures which, along with this withering revelation, she has poured out at their feet. No, if this,

after all, is the best that science can give me, give me then, I pray, no more science. Let me live on in my simple ignorance, as my fathers lived before me; and when I shall at length be summoned to my final repose, let me still be able to fold the drapery of my couch about me and lie down to pleasant, even though they be deceitful, dreams.

FACTS AS TO PARASITIC INVASIONS OF ANIMAL ORGANISMS.

To return from this long digression :—

In order that we may be able to judge of the probability that an infectious disease, of which the cause is unknown, is a result of the invasion of the blood or the viscera of the patient by a parasitic vegetation, it is important to consider first what has been already ascertained of the effects of such parasitic growths infesting the animal organism. A simple form of fungus, called the *Sarcina ventriculi*, is often found in matters thrown up by persons laboring under disorder of the stomach. It has also been met with in other parts of the body when diseased. But it is likewise found, and not unfrequently, in the stomachs of persons in perfect health; and, as Dr. Carpenter says, may accumulate there in considerable quantities without causing inconvenience. This parasite, therefore, cannot be regarded as an inciting cause of disease. The stomachs of many worms and insects are found, moreover, to be frequently infested with fungi, which grow there in great luxuriance. Many of these have been examined and described by Dr. Leidy, of Philadelphia. It does not appear that they occasion inconvenience to the animals within whose bodies they thus establish themselves. On the other hand, some of the dipterous and hymenopterous insects, and some caterpillars, are liable to invasion by fungoid growths, which speedily spread through their entire bodies and destroy their lives. In the West Indies, according to Dr. Carpenter, it is not at all uncommon to see individuals of a species of *Polistes* (corresponding to our wasp) flying about with plants of their own length projecting from some part of their surface, the germs of which have been introduced through the breathing-pores at their sides. This fungous growth, however, soon kills the insect, and a similar effect follows a similar cause in the case of certain caterpillars in New Zealand, Australia, and China, of which the bodies become so thoroughly interpenetrated and, as it may be said, replaced by the fungoid vegetation, that when dried they have almost the density of wood, so that, in the language of Dr. Carpenter, "these caterpillars come to present the appearance of twigs, with long, slender stalks formed by the projections of the fungus itself." Our common house-fly is a not unfrequent victim of a similar parasitic visitation. A fungus called the *Empusa Muscæ*, originating from the germination of a single spore, brought in contact almost anywhere with the body of the insect, pervades after a time its whole interior, and, while leaving the surface uninjured, emphatically eats out its substance. When the animal's life is nearly exhausted he comes to rest, and fungoid shoots put forth from his body on all sides, clothing him apparently with a kind of fur, consisting of filaments each bearing a fructification of innumerable spores. The harvest of spores becomes very conspicuous when the unfortunate animal makes his last stand upon the window-pane, forming a thin film over the glass to a considerable distance around him, and if by any chance a healthy individual of the same species comes within the limit of this infected area the disease which has destroyed his fellow will be sure to attack him also. There are some forms of parasitic disease affecting insects which have had consequences of serious importance to certain great industrial interests to which these humble forms of animal life are tributary. A fungus called the *Botrytis bassiana* is the occasion of the disease in silk-worms known by the name of *Muscardine*. The spores of this fungus, entering the breathing pores of the worm, soon germinate, and death is the invariable consequence. It is only, or at least rarely, however, the case that the cause of the fatality is manifest until after death has occurred; but then the fungus shoots forth luxuriantly, especially at the junction of the rings of the body. A still more destructive epidemic among silk-worms is that which has received the name of *Pébrine*, and which is caused by the multiplication of a parasitical organism called *Panhistophyton*, fungoid in its nature. This disease is the more difficult to deal with, in that it is transmissible by inheritance, the *Psorospermiæ* entering into the eggs of the diseased worm. It was thoroughly investigated by M. Pasteur, who pointed out the means by which it might be extirpated, means which have since been successfully applied. But there are diseases produced by invasions of parasitic fungi in animals of much higher grade than worms or insects. The epidemic among cattle, called in England "the blood," is shown by the researches of Davaine to be occasioned by the presence in the blood of the diseased animals of innumerable living organisms resembling *vibrios*. This disease is communicable to man, producing what is called "malignant pustule," and this is attended with the development of the same organisms in the pustules thus produced. Prof. Lister, an eminent surgeon of Edinburgh, long ago observed that when a chronic abscess is discharged by means of a *canula* and *trocar*, the subsequent accumulations of fluid are frequently attended with putrefication, though none had existed before. The putrid mass is also found to be swarming with *vibrios*, though none had been present in the first discharges. No explanation of this singular phenomenon, according to him, can be given except that the germs of these organisms were introduced in the original operation with the *canula* and *trocar*. Another remarkable fact noticed by Prof. Lister seems strongly to corroborate the theory of inflammation and putrefication above given. A wound in the chest, producing effusion of blood in the pleural cavity, is attended with great danger from the liability of the extravasated blood to putrefy. Yet when the lung is wounded by a broken rib, without any external opening, the blood, though escaping into the cavity in quantity, undergoes no decomposition and excites in the surgeon no concern, even though air at the same time enters in such volume as to inflate the cellular tissue of the entire body. "These facts," says Prof. Lister, "involved to me a complete mystery until I heard of the germ theory of putrefication, when it at once occurred to me that it was only natural that the air should be filtered of germs by the air passages" of the lungs. Now, what Prof. Lister conjectures *à priori*, Prof. Tyndall, interested by this remark, subsequently proved experimentally. Through the path of the beam of light made visible by his lantern in the dark room described above, he caused the air from his own lungs to pass, by breathing through a tube. The current at first but slightly affected the brightness of the beam; but as the air from the larger passages passed away, and that from the deeper network of the lungs succeeded, the light progressively faded, and at length gave place to absolute blackness. The experiment fully confirmed the anticipation of Prof. Lister, that the air which passed

through the lungs would no longer contain the germs of living things, or any other suspended foreign matter. But what an idea does this give us of our liability, through our lungs, to absorb into our system anything noxious which the air may contain, no matter how minute in quantity, or how finely divided? If the quantity in given volume is minute, it is to be remembered that the volume we inhale in a limited time is enormous, amounting to two or three thousand cubic feet a day; and the accumulation which must result, from even the partial exhaustion of this great mass of its impurities, must become very considerable.

PARASITIC DISEASES IN VEGETABLES.

Having spoken now of the cases in which disease, local or general, in animals, is manifestly occasioned, by the presence of parasitic vegetation, it is proper to mention, briefly, similar examples in plants. The smut in wheat, the rust in cotton, the *Oidium* in grapes, and the *Botrytis* in potatoes, are examples of fungi, constantly concomitant with disease, and presumably, almost certainly, in the last two instances, its cause. Neither in plants nor animals, however, is it to be supposed that the noxious effects observed are occasioned merely by the presence of these parasites mechanically interfering with and obstructing the vital functions, or by acting directly as poisons in the ordinary sense; but rather by their own vital activity decomposing the substance of the organisms they infest, and making them their food. The consequence of their extensive prevalence to the material interests of communities and peoples, and to their means of subsistence, have been occasionally of the gravest character. The *Oidium* may be said to have exterminated the vine from the island of Madeira; the *Panhistophyton* cut down the product of silk in France from 130,000,000 of francs per annum to 30.000.000; and the *Botrytis* threatened to depopulate Ireland, by destroying the vegetable which constituted for the common people the staple article of their food.

EXTENSION OF THE INQUIRY TO DISEASES IN GENERAL.

Putting together these known facts regarding this subject, before proceeding to more doubtful cases, we may say that the germ theory has an amount of *prima facie* evidence in its favor which entitles it to careful consideration. In certain instances, and in a certain sense, the evidence is complete that the germ theory is true. But when we come to apply it to infectious diseases in general, we find the analogies which they present, with the limited class of examples above enumerated, to be unexpectedly feeble, while the points of dissimilarity are numerous and marked. It is not enough to discover that in such diseases there are actually present in the blood, or in the tissues, or in the secretions, or in the dejections, of the suffering individuals, living forms of microscopic cryptogams, since the evidence is rarely conclusive either that these minute bodies are injurious to the patient or that they were present antecedently to the attack. And if, as to the first of these points, the evidence in some cases *is* satisfactory, as to the second it can hardly be pronounced to be so in any.

As to the frequent presence of vegetable organisms in the blood of men or animals suffering under infectious diseases, it is impossible to entertain a doubt. The testimony of all the observers who have occupied themselves with this subject is concurrent to this effect. Coze and Feltz, Kleb, Burdon-Sanderson, Klein, and many others, have found bacteria invariably in the blood of patients suffering under typhoid fever, smallpox, scarlet fever, puerperal fever, pyæmia, and septicæmia. Dr. J. H. Salisbury, of Cleveland, Ohio, affirms, as the result of his own observations, that in healthy as well as in diseased blood there are always present two species of cryptogams, the one algoid and the other fungoid. In the pustules of smallpox Dr. Salisbury has observed a cryptogam described by him as having both a fungoid and an algoid development, and the spores of this he has also found in the blood. In cowpox, or in the disease produced in the cow by inoculation from a smallpox subject, only the algoid form appears. This the discoverer has named *Ios vacciola*, while the entire plant in its double form is called *Ios variolosa vacciola*. In typhoid fever the same writer has detected a peculiar algoid vegetation developing itself upon the external surface of the entire body, and upon the mucous membrane of the interior cavities. This he regards as the efficient cause of the disease, and the means by which it is propagated. Dr. Ernst Hallier, of Jena, who has published largely on this subject, and has made himself prominent as an advocate of the germ theory, has described a large variety of vegetable forms, found by him in diseased men and animals, many of which he has subjected to systematic cultivation, in order to study their modes of development. A new and peculiar fungus, found in the rice-water discharges of cholera patients, and within the intestinal canal of such persons, has been cultivated by him with special attention. This plant is described as being as marvellous from the rapidity of its development as for its strange forms of growth, and its terribly fatal destruction of the epithelial tissue of the intestine. It is called by Professors Thorne and Klobe the *cylindrotœnium*, but is regarded by Dr. Simon and Dr. Harris as being an exotic member of the family to which belong the *urocystic* and *oidium* blights of cereals and fruits. Among the interesting facts observed in the cultivation may be mentioned that the presence of an abundance of nitrogenous matter, and the absence of acids in the fluid or substance employed, were proved to be essential conditions of the propagation and growth. Also, that when the fungus cells, in the course of their development upon a piece of intestinal membrane, reached a certain stage, they rapidly increased, and the epithelium as rapidly wasted away. After reading this, it is rather disappointing to find in the last and recently published edition of Dr. Parkes's *Manual of Practical Hygiene* the following succinct statement: "As regards cholera, the careful observations of Drs. Lewis and Cunningham, in Calcutta, seem to have disproved the possibility of either fungi or bacteria being the *cause* of cholera."

The disease which appeared in 1868 among the beef cattle brought to this city from the west, and which is known as the Texas cattle disease, was investigated at the time by Drs. Harris and Stiles, of the New York Health Department, who found the spores of a peculiar species of fungus both in the blood and in the bile of the diseased animals. Specimens of these cryptogams were sent by these gentlemen to Prof. Hallier, by whom they were successfully cultivated, and who succeeded in deriving from them three distinct forms of the fungus. The epizootic, which attacked all the horses of the country twelve months ago, was also marked by the presence of fungi in the blood and the urine of the animals affected, which were described by Dr. Endemann, and by Dr. Charles Am Ende, of Hoboken.

ARE THE PARASITES THE EFFECT OR THE CAUSE OF THE DISEASE?

These examples will probably be thought sufficiently numerous to justify the generalization that in infectious diseases the presence of microscopic algoid or fungoid cryptogams is a fact of invariable occurrence. What is the significance of this fact? In all these cases, we find that the fluid in which the cryptogams occur is itself diseased. Is not the disease of the blood the very condition that is necessary to the development of the plant? When mould makes its appearance on the surface of paste, is it the presence of the mould which causes the paste to putrefy, or is it the putrefaction of the paste which provides a congenial nidus for the mould?

About forty years ago, the yeast plant was discovered by Cagniard de la Tour, and almost simultaneously by Schwann. Till that discovery, the chemical theory of disease had a strong support in the imagined analogy of fermentation. To the suggestion, after the discovery, that fermentation is probably a consequence of the rapid growth of the plant, there was at first a very general and natural dissent, but when, in 1843, Helmholtz made a direct experimental test of the question, by placing a fermenting liquid side by side with one of the same kind not fermenting, both being contained in the same vessel but separated by a membrane which permitted the mingling of the liquids, but prevented the passage of the plant, that analogy lost its force, for the fermenting liquid continued to ferment, while the quiescent liquid remained quiescent. The case of fermentation assumed now a significance quite the contrary of that which it had before seemed to possess, and it began to be claimed quite as conclusive in favor of the germ theory, as it had been before in favor of the chemical. This theory, however, though among its advocates have been, and continue to be, counted many of the most distinguished physicians and physiologists of the past and the present generation, has never met with universal acceptance. Serious difficulties present themselves, which it fails to explain, among which are the objections strongly put by Dr. Bastian, that the theory demands a belief in the existence of about twenty different kinds of organisms never known in their mature state, and whose existence is not demonstrated, but simply postulated; and that these germs, if they exist, are not the germs of any known organisms, because such germs have been experimentally shown to be incapable of producing the particular diseases these are assumed to cause. Moreover, feeding on putrid flesh, as is habitual among the Kalmucks, is followed by no injurious consequences, though such flesh swarms with bacteria, and, as the author just referred to affirms, the organisms of ordinary putrefactions may be introduced even into the blood of men and animals without producing any of these specific diseases. The same writer asserts that in sheep-pox the blood and the secretions are not infective, though this disease is allied to, and even more virulently contagious than, human smallpox.

What account shall we give, therefore, of the multiplication of fungi and algæ in diseased blood, if these organisms are not the cause of the disease? Simply, that the diseased condition furnishes to the organisms the pabulum, which is not present in the healthy state. For the cause of the disease we must, on this supposition, look elsewhere, and we shall be compelled, perhaps, to fall back upon the chemical doctrine of sympathetic decomposition. Many causes, in fact, produce profound changes in the blood with which parasites have nothing to do. This is true of the venom of serpents and of prussic acid, both of which produce fatal effects with singular rapidity. Of "the black death," which raged in the fifteenth century, Bastian quotes Hecker as saying that "many were struck as if by lightning, and died on the spot," and he cites the testimony of Dr. Aitken to the fact that, when the cholera reached Muscat, instances occurred in which only ten minutes elapsed from the first apparent seizure till life was extinct. These are cases for which the germ theory affords no solution.

On the other hand, we have the numerous observations and experiments of Coze and Feltz, of Burdon-Sanderson and Klein, of Klebs, of Davaine, of Zahn and Tiegel, and others, in which rabbits and guinea-pigs were inoculated with bacterious blood drawn from patients laboring under a great variety of infectious diseases, including pyæmia, septicæmia, smallpox, measles, scarlet fever, typhoid fever, etc., observations and experiments which seem to leave little room for doubt that these organisms are, in fact in these cases, the vehicles of the infection, and the causes of these several diseases. It was observed, for instance, that successive inoculations increase the intensity of the virus, and that along with the increase of toxic power, the number of the organisms in the fluids manifesting it was correspondingly increased. It is true that the diseased fluid is itself necessarily introduced into the animal inoculated, along with the contained bacteria, so as to leave the question still somewhat in doubt to which to ascribe the induced disease. Some light is thrown upon this question by certain experiments of Drs. Zahn and Tiegel, who in cases of septicæmia filtered the parasites from the liquid; and having done this, found that the clear liquid caused heavy but transient fever without suppuration, while the same fluid with the parasites produced suppuration extraordinarily widespread.

NEITHER THEORY TO BE HELD TO THE EXCLUSION OF THE OTHER.

In view of the conflicting character of the evidence surrounding the vexed problem under consideration, the conclusion to which the present speaker has been led, if it may be permitted to one so moderately versed in physiological science to have a conclusion at all, is that neither the germ theory of contagious disease, nor the chemical theory, is exclusively true, but that each of these morbific influences has a range of action of its own, and that in some cases it is eminently probable that the disease in its inception is attributable to one of these causes, and that is the chemical; but owes its subsequent virulence mainly to the other, that is, to the presence of rapidly-multiplying vegetable organisms. It appears to me that by the proper application of this key we shall be able to solve most of the perplexing anomalies which particular examples have seemed to present, and shall afford a common ground on which the champions of opposing views may meet and harmonize their differences. I make the suggestion with much diffidence, conscious how far I am stepping beyond my own proper province in doing so; but also on that very account to a certain extent reassured by the consideration that, whatever acceptance it may meet with in this learned body, I have no professional reputation to be prejudiced or advanced in making it.

BEARING OF THE QUESTION UPON PUBLIC HYGIENE.

As to the bearing of this question upon public hygiene and the principles which should govern sanitary legislation, it is to be observed that, if we accept the chemical

theory of contagion as conclusively the true one, we can hardly avoid admitting the possibility that contagious disease may originate in a healthy individual without communication with a person already diseased. The causes, whatever they may be, will be found in surrounding conditions. If I have understood what has been said during the present session of this association, the cholera in the West during the season that is past did not originate from without. Somewhere conditions must have existed which favored its origination *de novo* in our own country. In this view of the subject, the business of sanitary science is to discover the nature of the deleterious conditions tending to induce disease, and to prevent their occurrence.

If, on the other hand, infectious disease is propagated by living germs alone, what we have to aim at is to devise measures for promptly extirpating those germs the moment the disease appears. But as the necessary measures of precaution or of extirpation will be substantially the same, whatever may be the theoretic views entertained as to the nature and the origin of the evil to be met, our legislation in any case is likely to be practically the same, however in its motive it may be logically different. Pure air, pure water, wholesome food, thorough drainage, rigidly-enforced cleanliness, the severe exclusion from towns and cities of industries which contaminate the air with noxious gases or offensive effluvia, especially such as arise from decaying organic matter, the prevention of overcrowding in dwellings, the prompt and complete disinfection of every spot where pestilence may lift its head and of every article and substance, including the dejecta of the sick, which may serve as a vehicle of disease, and finally, a well-organized sanitary police and untiring vigilance on the part of its members—these are the objects which the guardians of the public health must labor to secure, to whatever school of etiology they may happen to belong. It is indeed a fortunate circumstance, a fact observable in no other department of practical human effort that I happen to remember, that here the champions of conflicting theories, however freely they may splinter lances in the arena of controversy, are always found in the field of actual warfare, and in the face of the common enemy marching harmoniously side by side.

The study of the laws of hygiene is assuming in our time, in the estimation of the public and of the profession themselves, an importance which places it above even the proper business of the profession, that of the science of Therapeutics. Drugs, whether remedial or prophylactic, are falling more and more into disrepute; and it is felt that prophylactic action is infinitely better than prophylactic draughts.

Such has been the success of modern measures for closing up all the insidious approaches by which disease has hitherto effected its entrance into the family, the community, or the individual organism, as to encourage a hope, even so seemingly wild and visionary, as that a time is coming in which disease itself shall be utterly extirpated, and men shall begin to live out the days which Heaven intended for them. When that time arrives, if it ever shall, your honorable and learned profession may find, like *Othello*, its occupation gone; but it will be itself which will have destroyed it, and which will have established, in doing so, a nobler title to the gratitude of mankind than all its untiring labors for the relief of suffering humanity through centuries of self-sacrificing devotion hitherto have already won.

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS.

In the preparation of these abstracts the Editors are assisted by the following chemists:—

M. Alsberg, Ph.D.,
Prof. G. F. Barker,
T. M. Blossom, E.M.,
H. C. Bolton, Ph.D.,
G. C. Caldwell, Ph.D.,
Prof. T. Egleston, E.M.,
H. Endemann, Ph.D.,
C. A. Goessmann, Ph.D.,
S. A. Goldschmidt, E.M.,
E. J. Hallock,
R. Hitchcock,
S. Hughes,
H. C. Humphrey,
C. A. Joy, Ph.D.,
J. P. Kimball, Ph.D.,
Louis H. Laudy,
J. M. Merrick, B.Sc.,
H. Newton, E.M.,
Prof. F. Prime, Jr.,
Ira Remsen, Ph.D.,
C. A. Schaeffer, Ph.D.,
P. Schweitzer, Ph.D.
W. Shapleigh,
T. O'C. Sloane, E.M.,
Prof. A. P. S. Stuart,
D. K. Tuttle, Ph.D.,
E. Waller, E.M.,
E. H. Williams, A.B.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.

No. 5.

On the nature of **bleaching powder.**—C. Göpner.—When sulphuric acid is allowed to act upon freshly prepared, dry bleaching powder, only chlorine, and not a trace of hypochlorous acid, is obtained. If bleaching powder that has been acted upon by the air and is moist is employed, hypochlorous acid is produced. The formula $CaOCl_2$ for the bleaching compound is the correct one.

Concerning the **ammonia soda-process.**—A. Bauer.—The process, as is known, consists in the formation of soluble sodic bicarbonate by the action of ammonic bicarbonate on a solution of sodic chloride. There is always a loss amounting to about one-third of the sodic chloride employed. This is partially due to the property of sodic bicarbonate (and carbonate) to form sodic chloride with ammonic chloride.

On the estimation of actylene in gas-mixtures and on the composition of **acetylene-copper.**—R. Blochmann.—The composition of acetylene-copper is

$$C_2H_2Cu_2O = \begin{matrix} CH \\ \| \\ (CCu_2OH) \end{matrix} \quad \text{or} \quad \begin{matrix} C \\ \| \\ C \end{matrix} \!\!>\!\! Cu_2 + H_2O.$$

The formation in ammoniacal cuprous chloride solution takes place thus:—

$$Cu_2Cl_2.2NH_3 + H_2O + C_2H_2 = C_2H_2Cu_2O + 2NH_4Cl.$$

The decomposition with mineral acids is explained thus:—

$$C_2H_2Cu_2O + 2HCl = C_2H_2 + Cu_2Cl_2 + H_2O.$$

The author recommends the estimation of copper in the compound of acetylene when it is necessary to estimate the quantity of acetylene.

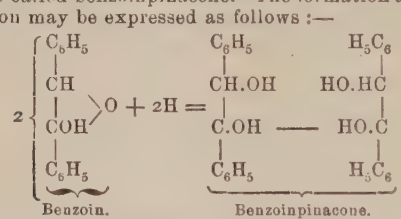
On the formation of anthracene from **benzylchloride** by heating with water.—M. Fincke.—The action of water on benzylchloride takes place in an entirely analogous manner to that of the action of zinc in a mixture of benzylchloride and aromatic hydrocarbons. There is first formed a number of bodies among which is the chloride $C_{14}H_{13}Cl$ and hydrocarbons of high boiling points. Anthracene is produced by distilling the first crude product. The hydrocarbons, obtained as secondary products by the action of zinc on mixtures of benzene or toluene with benzylchloride, conduct themselves in a similar manner, yielding by distillation anthracene.

On the transformation of **diazonitrobenzenes in nitrophenols.**—R. Fittig.—The diazo-compound from nitranilin (of fusing point 146°) is readily converted into nitrophenol fusing at 114°. The transformation of diazo-compounds into corresponding oxy-compounds takes place normally.

Investigations on alcohol **fermentation.** — Oscar Brefeld.—The following results are given: 1. Alcohol yeast requires, for its development and propagation, oxygen. 2. If access of air or free oxygen is prevented, the yeast cannot grow in its nourishing liquid. 3. Yeast has a great affinity for free oxygen, and extracts sufficient for its growth from an atmosphere containing $\frac{1}{8000}$ volume of free oxygen. 4. Both processes, growth and propagation of the yeast cells without fermentation, and fermentation without growth and propagation, may be easily and positively separated. If oxygen is supplied freely, growth and propagation take place without fermentation. If the yeast be placed in a solution of sugar and access of air be entirely prevented, fermentation takes place without growth and propagation, the yeast dying in the process. The CO_2 given off under these circumstances is absolutely pure, not containing a trace of oxygen.

Communications from the University-laboratory at Würzburg—J. Wislicenus :—

I. **Benzoin derivatives.**—H. Goldenberg.—When benzoin is heated with HI, it yields dibenzyl. Desoxybenzoin and toluylene-hydrate both yield dibenzyl under the same circumstances. When zinc and alcoholic HCl act upon benzoin, a body of the formula $C_{28}H_{26}O$ is formed. This is called benzoinpinacone. The formation and constitution may be expressed as follows :—



Benzoin. Benzoinpinacone.

II. **Silver-derivative of biuret.**—J. Bonnê and H. Goldenberg.—Pure biuret dissolved in water was treated with argentic nitrate, and ammonia then gradually added. A precipitate was formed which had the formula $C_2H_3Ag_2N_3O_2$, characterizing it as diargentbiuret. This compound is decomposed by heat, and the silver is left behind still containing some argentic paracyanate.

III. **Silver-compounds of melamine.**—C. Zimmerman.—When a mixture of the hot solutions of melamine and $AgNO_3$ is allowed to cool, $C_3N_6H_6.AgNO_3$ is formed. When this compound is heated with an excess of a strong solution of $AgNO_3$, a substance of the formula $C_3H_6N_6.2AgNO_3$, melamine-diargentnitrate, is formed. This latter substance treated with NH_3 yields diargentmelamine, $C_3N_6H_4Ag_2$.

IV. **Constitution of ethyl phosphite and phosphorous acid.**—C. Zimmerman.—There are at present two views held concerning the constitution of phosphorous acid and its derivatives. According to the first the acid is $P{=}O(H)$; according to the second, $P(OH)_3$. If the ether is derived from an acid of the first formula, it must by saponification yield ethylphosphinic acid. The results of the experiments made prove that phosphorous acid has the formula $P(OH)_3$.

V. **On secondary-normal butyl ethylate.**—Fr. Kessel.—This substance, $\left.\begin{matrix}CH_3\\C_2H_5\end{matrix}\right\}CH.O.CH\left\{\begin{matrix}CH_3\\C_2H_5,\end{matrix}\right.$ was prepared by the action of ethylidene oxychloride, $CH_3.CHCl.O.CHCl.CH_3$, upon zinc-diethyl in anhydrous ether.

VI. **Action of nascent hydrogen on dinitroethylic acid.**—S. Zuckerschwerdt.—The zinc salt of the acid, $(C_4H_{10}N_4O_4Zn)_2 + H_2O$, or also $C_4H_{10}N_4O_4Zn + H_2O$, was treated with sodium-amalgam, and in other experiments with zinc-dust, iron-filings, and caustic soda, and the mixtures distilled. The action takes place as follows :—

$$C_2H_5.N_2O_2.H + 8H = \underset{\text{Ethylamine.}}{N(C_2H_5)H_2} + NH_3 + 2H_2O.$$

The formula $N{-}C_2H_5$ (with $N{-}OH$) appears probable.

VII. Addition-product of **sulphurous acid and zinc-ethyl.**—S. Zuckerschwerdt.—The product is ethylsulphonic acid, $C_2H_5.SO.OH$. This acid when oxidized with nitric acid yields ethylsulphonic acid, $C_2H_5.SO_2.OH$, and an acid of the constitution $(C_2H_5.SO_2)_3N{=}O$, which is called trisulphonethyl-nitrogen-oxide.

VIII. **Mercuridiphenylammonic chloride.**—C. Foster.—This compound, $NC_6H_5.Hg.HCl$, is produced, together with $N_2(C_6H_5)_2HgH_4Cl_2$, when boiling solutions of aniline and mercuric chloride are mixed.

IX. Action of **mercuridiphenylammoni cchloride upon substituted thioureas.**—C. Foster.—With diphenylthiourea, triphenylguanidine $CN_3(C_6H_5)_3H_2$ was obtained. With monophenylthiourea, diphenylguanidine was the product. Allyl-ethylthiourea yielded allyl-ethyl-phenylguanidine.

X. Constitution of **isomeric crotonic acids.**—V. Remilian.—The isocrotonic acid of Geuther is converted into ordinary crotonic acid by heat. From experiments made and described it appears that ordinary crotonic acid has the formula $CH_3{-}CH{=}CH.CO_2H$.

Compounds of **thallium with alcoholic radicals.**—F. C. Hartwig.—Thalliumdiethyl chloride is prepared by the reaction expressed as follows :—

$$TlCl_3 + Zn(C_2H_5)_2 = Tl(C_2H_5)_2Cl + ZnCl_2.$$

From this were prepared thalliumdiethyl sulphate $[Tl(C_2H_5)_2]_2SO_4$, the phosphate $[Tl(C_2H_5)_2]_3PO_4$, the nitrate $Tl(C_2H_5)_2NO_3$, the acetate $[Tl(C_2H_5)_2]C_2H_3O_2$, the iodide $[Tl(C_2H_5)_2]I$, and the hydroxide $Tl(C_2H_5)_2(OH)$. The preparation of thalliumtriethyl was not accomplished.

On the preparation of **thalliumtriethyl.**—L. Carius and C. Fronmüller.—Thalliumdiethyl chloride and mercury diethyl acted thus :—

$$Tl(C_2H_5)_2Cl + Hg(C_2H_5)_2 = (C_4H_{10})_2 + TlCl + Hg.$$

The triethyl compound could not be obtained.

On **aluminium-platinic chloride.**—A. Welkow.—The salt was obtained by mixing solutions of aluminic chloride and platinic chloride. It has the formula $Al_2Cl_6 + 2PtCl_4 + 30H_2O$. It crystallizes in well developed crystals of the triclinic system.

On a few derivatives of **α- and β diamidonaphtalenes.**—A. de Aguiar.—The bases themselves are exhaustively described, and, further, the oxalates and diazo compounds. By the action of ethyl oxalate on β-diamidonaphtalene a substance of the formula

$$C_{10}H_5(C_2H_5)\begin{matrix}NH{-}CO\\|\\NH{-}CO\end{matrix}$$

was produced. This is β-ethylnaphteneoxamide.

Synthesis of **tetramethylsuccinic acid.**—C. Hell and A. Wittekind.—Consists in allowing silver to act

upon ethyl monobromisobutyrate. The acid is isomeric with subacylic acid. Its formula is

$$HO_2C-\overset{CH_3}{\overset{|}{C}}-\overset{CH_3}{\overset{|}{C}}-CO_2H.$$

On **synthetical cymene** from normal propyl bromide and crystallized bromtoluene.—F. Fittica.—The cymene thus prepared was found to be identical in every respect with the varieties obtained from ptychotis-oil, thymol, and camphor. The propyl contained in all of them is hence normal propyl, and the propyl and methyl groups occupy the positions 1·4.

Method for the preparation of **bases containing no oxygen.**—O. Wallach.—By the action of PCl_5 upon diethyloxamide the author obtained a base of the formula $C_6H_9ClN_2$. This is the product of a secondary reaction. First the following reaction takes place:—

$$\begin{matrix}CO.NH.C_2H_5\\|\\CO.NH.C_2H_5\end{matrix} + 2PCl_5 = 2POCl_3 + \begin{matrix}CCl_2.NH.C_2H_5\\|\\CCl_2.NH.C_2H_5\end{matrix},$$

then $C_6H_{12}Cl_4N_2 - 3HCl = C_6H_9ClN_2$.

The new base is called monochloroxalethyline. It is poisonous, and resembles in many respects the alkaloids of the nicotine group. A number of salts of the base were prepared. The action of PCl_5 upon other substituted amides of bibasic acids will be studied, and it is hoped that this may lead to the synthesis of the alkaloids.

Concerning the constitution of **substituted phenols.**—J. Post.—This paper contains a careful comparison of all the known substitution-products of phenol. By a consideration of the transformations of these products thus far studied the author shows how, by means of experiment alone, and without the aid of hypothesis, positive conclusions may be drawn with reference to the positions occupied by the substituting groups.

On some new derivatives of **brominated anilins.**—L. Remmers.—The following derivatives were prepared: Nitrobromacetanilide, nitrodibromacetanilide, nitrotribromacetanilide, and nitrotribromdiactanilide. From the first of these were obtained nitrobromanilin, bromphenylenediamine, and ethenylbromphenylenediamine. From the third, nitrotribromanilin.

On the preparation of **acetylene.**—The gas is best prepared by passing ethylene chloride in the form of vapor through a strongly ignited porcelain tube containing unslaked lime or soda-lime.

$$C_2H_4Cl_2 + CaO = CaCl_2 + H_2O + C_2H_2.$$

Action of **hydrogen on acetylene and ethylene** in contact with platinum black.—Ethyl hydride is formed, as was proved by analyses of the product.

Preliminary communication on the action of the electric current in **some gases and gas-mixtures.**—SO_2 and O combine to form SO_3. The product of the action of the current upon ethylene was not examined, but it was shown that condensation takes place. Acetylene is entirely converted into a solid body which has not yet been thoroughly examined. I. R.

Les Comptes Rendus de l'Académie des Sciences.

Vol. 78, No. 4.

Production of **yeast in a saccharated mineral menstruum.**—E. Pasteur.—The author reviews his former experiments, insisting upon his own accuracy, and controverting Liebig's statements. He exhibited a glass globe which contained originally distilled water, sugar candy, ashes of yeast, and an ammoniacal salt, and into which has been introduced an almost imponderable trace of yeast.

The fermentation had been active, and yeast in large quantity produced. The sugar had completely disappeared without undergoing anything but the alcoholic fermentation. The author calls attention to the fact, that yeast which has grown in a saccharated mineral menstruum is better suited to propagate in such a menstruum; it has become acclimated, so to speak, like plants in certain soils.

Acetylene liquefied and solidified by the electric current.—P. and Arn. Thenard.—In submitting acetylene in M. Arn. Thenard's apparatus to the action of the electric current, the authors have obtained two new bodies or liquids, in very minute quantities, having the elementary composition of gaseous acetylene (as also has the second), and a solid vitreous or horny substance, very hard, and of the color of wine lees. The authors have not succeeded in distilling solid acetylene. Berthelot thinks that the solid may be a bitumen.

Upon the presence of a considerable amount of **nitre in two varieties of Amaranthus.**—A. Boutin.—The author has proved the presence of a considerable quantity of nitrate of potassa in amaranthus bitumen, A. atropurpurens and A. melancholicus ruber.

A. ruber contains 16 per cent. of nitrate of potassa, and A. atropurpurens 22·77 per cent. The author thinks that at some future time this family of plants may be cultivated for nitrogenous fertilizers.

Upon some peculiarities of the efflorescence of the two **hydrates of sulphate of soda.**—M. D. Gernez.—The author coated glass rods with a pellicle of ordinary sulphate of soda, and after keeping it in dry air for nine months and a half, found that it had not lost its property of producing crystals of the original form. On the other hand, it is known that the ordinary sulphate of soda treated to 33° or 34° for a few minutes is wholly inactive. The author does not draw from these facts the inference of Coffet, viz., that there are two isomeric sulphates of soda, but supposes that, when, by dropping this dehydrated salt into a saturated solution, certain crystals are formed, the result comes from the fact that the dry salt contains an infinitely small quantity of salt not dehydrated and sufficient to bring about the crystallization noticed.

Reaction of **chloride of silver upon biniodide of phosphorus.**—Arm. Gautier.—This paper details the attempts of the author to obtain a bichloride of phosphorus corresponding to the biniodide, by making chloride of silver react upon this latter substance.

The experiment failed, the reaction brought about being expressed—

$$3PI_2 + 6AgCl = 2PCl_3 + 6AgI + P,$$

phosphorus being liberated and the terchloride formed.

The author calls attention to the following striking facts, viz.:—

1. When chlorine displaces iodine in iodide of phosphorus, this reaction does not preserve the primitive type of the binodide, three atoms of chlorine taking the place of two of iodine.

2. Chloride of silver sets at liberty at a low temperature a part of the phosphorus of the biniodide, a sufficiently singular reaction, when we consider that it is effected by a chemically saturated body (AgCl) acting upon a body formed with energetic emission of heat.

3. The phosphorus produced is the *ordinary* kind, while the experiments of the author and M. Lemoine would lead one to suppose it would be amorphous.

Upon the **isomerism of terebenthene and terebene**, physically considered.—J. Ribau.—The results

of experiments made upon carefully prepared samples of terebenthene and terebene show that—

1. The rotatory power of terebenthene = −40°·32 (42°·3 Berthelot)
" " " " terebene = 0.
2. The boiling point of terebenthene = 156°·5
" " " " terebene = 156°·0
3. The density is—

Terebenthene.		Terebene.	
At 0°	·8767	At 0°	·8767
" 17°·88	·8619	" 19°·68	·8604
" 39·74	·8439	" 39·08	·8443
" 59·38	·8277	" 59·80	·8267
" 19·59	·8107	" 80·87	·8089

4. The index of refraction for terebenthene for the red, yellow, green, and blue rays respectively is ·002, ·0023, ·0023, ·0024 higher than that of terebene.

5. The specific heat of terebenthene is a little greater than that of terebene.

Upon the **production of crystals of oxalate of lime and phosphate of ammonia and magnesia.**—E. Monier.—The author, in experimenting by superposing upon each other liquids capable of giving rise to certain chemical reactions, arrives at the following rules, viz.:—

1. When liquids of different densities can produce a very dense precipitate, the mixing as in the case of subacetate of lead and chloride of sodium can take place in a few days.

2. When the liquids cannot produce a precipitate the mixing goes on very slowly, as in the case of water colored blue by tournesol and sulphuric acid.

No. 5.

Conditions in which **lead is attacked by water.**—A. Bobierre.—The author repeats his conviction, as the results of experiments, that water attacks lead principally in those cases where the air and the water act together or alternately upon the metal.

Remarks upon M. Bobierre's communication.—Belgeand.—The author quotes a letter from Dr. Letheby upon the London water, the substance of which is—

1st. The main distributing water pipes in London are cast-iron.

2d. The pipes leading from the mains into houses are almost always lead.

3. The distributing pipes in the houses are invariably lead.

4th. Cisterns are almost all of wood with a leaden lining, galvanized iron or zinc-lined tanks being the exception.

As to the action of water upon lead, I may say that our researches show as a result that where the water contains 5 or more parts of lime salts (sulphate) to 100,000 parts of the water, the water may be kept in lead-lined tanks, and distributed through lead pipes without inconvenience. But if the salts are the chlorides and nitrates, the lead is attacked and the water becomes insalubrious.

Action of ordinary **water and distilled water,** as well as sea water distilled, **upon lead,** and upon the tin coolers in the distilling apparatus.—L. Besnau.—Resumé of experiments:—

1. Water and rain water attack freshly-cut lead with promptitude.

2. Water distilled from fresh or salt waters attacks, in the state of vapor, the lead and tin condensing apparatus. The orange-flower water of commerce often contains traces of lead.

3. The discovery of the action of distilled water upon lead is attributed to Guyton Morveau.

4. It is difficult to decide which of the salts found in fresh water acts to protect the lead, but the author thinks alkaline carbonates and the sulphate of lime are more energetic in this respect.

5. Waters for drinking purposes, passing rapidly through lead pipes in a continual current, do not dissolve a notable proportion of the metal.

6. To explain the action of distilled or rain water upon lead, the author believes we must look to an electrochemical influence put in action by the joint agency of the air, nitrogen, and the water.

Upon the **oxalurate of ethyl** and the cyanurate of oxamethane.—E. Grimaux.—Oxaluric acid contains the elements of oxamic acid, $C_2H_3NH_2$, and those of cyamic acid, CONH, as urea contains the elements of cyanic acid and ammonia. The author's theory then was that oxaluric acid might be prepared by making a cyanate of oxamic acid which would spontaneously convert itself into oxaluric acid as cyanate of ammonia is transformed into urea.

He fused in an oil bath at 130° 5 grammes of dry and pure oxamethane, and directed upon it the vapor derived from heating 3 grammes of cyanuric acid. The resulting product, repeatedly crystallized from boiling water, forms brilliant fragile needles almost insoluble in cold water, soluble in 30 parts of boiling water, fusing between 155° and 160°, readily decomposed by boiling with milk of lime, giving a product containing the same percentage of base as oxamate of calcium.

The author has established the constitution of this cyanurate of oxamethane by examining its baryta and ammonia precipitates, the first proving to be cyanurate of baryta, and the second oxamide.

Upon the **pretended disengagement of ozone by plants.**—J. Bellucci.—The author, in a paper which gives the details of a series of elaborate experiments, shows that plants do not exhale ozone, and that the opinion of Cloez in this matter is correct, against the assertion of Scoutteten.

On the action of **water upon lead.**—Balard.—The substance of the author's paper is that lead is oxidized in contact with aerated water. If it finds in that water a salt with which the oxide can form an insoluble compound, that compound is formed, and, coating the metal, guards it from further attack. On the other hand, if the water be pure, or contain salts whose acid cannot form an insoluble salt with lead, such as nitric, acetic, and formic acids, the action is energetic. Boussingault declares that drainage waters rich in nitrates and running through lead pipes have occasioned fatal accidents.

Decolorizing power of sulphide of lead.—Hartsen.—In an article upon the uredo of maize, the author takes occasion to make the following remarks upon the action of sulphide of lead. Precipitated sulphide of lead has the power of absorbing and retaining several substances, as resins, coloring matters, etc.

In decolorizing power it does not yield to animal charcoal, and in certain cases has an advantage over it, 20 grammes of sulphide of lead sufficing to decolorize 90 grammes and more of red wine. The absorbent power of sulphide of lead should be borne in mind when acetate of lead is used to isolate acids and other constituents of plants.

After having decomposed the precipitate by sulphydric acid, care should be exercised not to throw away the sulphide without having first exhausted it with boiling alcohol.

In extracting chlorophyl from leaves by benzine (instead of ether), the leaves should first be moistened with alcohol.

J. M. M.

Moniteur Scientifique.

Series III. Vol. iii., No. 384, December.

Antimony-blue.—Krauss.—The pigment, introduced into commerce some years ago under this name, prepared by precipitating a solution of antimony in aqua regia by potassium ferrocyanide, the author has examined and finds to contain no antimony. He succeeded in preparing it from tartar emetic, by precipitating as above a strongly acid solution of this salt. The antimony seems not to be necessary, since a solution of mercury gives the same results; it only accelerates the precipitation. The blue itself is only another of the cyanogen and iron compounds.

Phospho-tungstic acid as a reagent for organic bases.—Scheibler.—Sodium tungstate of commerce, boiled with phosphoric acid, the alkaline solution neutralized with chlorhydric acid, and precipitated by a barium salt, yields phospho-tungstate. This, decomposed by sulphuric acid, yields phospho-tungstic acid, crystallizing in cubes. This acid precipitates all the organic bases, most of them quantitatively. Solutions of $\frac{1}{200000}$ of strychnine or $\frac{1}{100000}$ of quinine are readily precipitated. At first the precipitates are flocculent, but by standing they become so dense as to be easily washed by decantation. The author exhibited magnificent crystals of betaine, precipitated by this reagent from beet-root molasses and subsequently purified.

Ammonia-nitrometry, etc.—Piuggari.—A method for the volumetric determination of nitrogen in all its forms, by first oxidizing it to nitrons and nitric acids by the action of a mixture of silver chloride and potassium hydrate for two or three hours at 55° to 60° C., and then reducing to ammonia by the joint action of the alkali hydrate and aluminum filings. The ammonia is then determined by Nessler's test if it contains less than $\frac{1}{100}$ of a milligramme to the cubic centimetre; if more, by a special reagent founded on the simultaneous reaction of one or two drops of phenol and five or six c. c. of sodium hypochlorite (Labarraque's solution). A beautiful blue-violet color is developed in presence of ammonia, the depth of which, compared with a normal solution, gives the content in ammonia. The method is specially applicable to natural waters.

On a new mode of **tempering steel.**—Regeneration of burned iron.—H. Caron.—The steel is hardened in water at 55° C. Burned iron is restored by plunging it at a red heat into a saturated solution of salt.

Preparation of **hydrochloric acid pure.**—Zettnow.—The acid of density 1·16, free from iron, is treated with a little chlorine-water, and then with the salt of tin of commerce, 5 grms. to the kilogramme. It is kept at the temperature of 30° to 35° for 24 hours. The arsenic is then volatilized, and, after standing for 3 or 4 days to become clear, it is distilled from a little salt. It is then perfectly pure.

No. 385, January.

Breaking cast-iron guns with dynamite.—Champion.—The cannon is filled with water and inverted. The explosion of the dynamite placed at the lower end, being transmitted through the water, fractures the gun.

Effect of soap-water on **incandescent metals.**—Barrett.—A red-hot copper ball plunged beneath the surface of water containing soap, remains quiet, being surrounded with a thick envelop of vapor.

No. 388, April.

On the **reduction of ferric to ferrous salts** in the quantitative analysis of iron minerals.—Ad. Kopp.—The author calls attention to the fact that the tediousness of reducing the iron solution by zinc is vastly relieved by the addition of a little stannous chloride previously. The zinc subsequently added reduces the tin to the metallic state, when it is removed by filtration and the liquid titred as usual.

Action of **hydrogen sulphide on chloral hydrate.**—G. Wyss.—When hydrogen sulphide gas is passed into a concentrated aqueous solution of chloral hydrate, a mass of crystals forms having after purification the composition $\left.\begin{matrix}CCl_3.CHOH\\CCl_3.CHOH\end{matrix}\right\}S$.

On the use of **dried potassium ferrocyanide** in place of the cyanide in producing organic cyanide.—C. N. Witt.—Finds the yellow salt to answer perfectly.

No. 389, May.

Contributions from the Technical Laboratory of the Polytechnic at Zurich. I. On the **oxyphenyl-sulphites of ortho- and of para-toluidine.**—Lecco.—Paraoxyphenylsulphurous acid was prepared by heating together phenol and sulphuric acid. Mixed with toluidine (paratoluidine) a crystalline mass of paratoluidine paraoxyphenylsulphite was obtained, which after purification yielded on dry distillation two sulphotoluidic acids, one, α, crystallizing in clear yellow needles, being identical with that described by Sell, the other, β, in the form of rhombic tables. Ortho-toluidine paraoxyphenylsulphite was prepared from pseudo-toluidine in the same manner. The orthosulphotoluidic acid obtained from the destructive distillation is identical with that described by Limpricht.

II. On the point of fusion of the **alloys of lead and zinc.**—Guehm.— The results are:—

Alloys. Lead.	Zinc.	Softening point.	Fusing point.
2	5	185°	189°
2	6	189°	194–195°
2	7	192°	198°
2	8	202°	208–210°.

New process for **preserving wood.**—Hatzfeld.—By the injection of ferrous tannate, which becomes insoluble in the wood by oxidation. G. F. B.

Les Mondes.

September 11, 1873.

On the **solidification of protoxide of nitrogen.**—M. F. Wills.—Protoxide of nitrogen can be easily solidified by passing a rapid current of air through the liquefied gas. The protoxide of nitrogen is liquefied at —92° and solidified at —99°; its density at 0° is 0·9004, in the liquid state, when it is insoluble in water.

On a new series of **aromatic hydrocarbons.**—M. Th. Zincke.—In the reaction of zinc powder on a mixture of benzene and chloride of benzyl, there are produced besides diphenylmethane (benzylbenzene) other hydrocarbons which are the subjects of the author's investigations. The compositions of the two hydrocarbons obtained are the same, and the author regards them as as isomeric dibenzyl-benzenes ($C_{20}H_{18}$); one, however, appears to be a tribenzyl-benzene, $C_{26}H_{24}$.

Grape sugar and sugar of milk.—M. Champani.—A concentrated solution of subnitrate of lead added to a dilute solution of acetate of copper is used as a reagent, and the liquid to be tested is added to 5 c. c. of this solution raised to the boiling point; if it contains grape sugar the mixture is colored and leaves a yellow precipitate; cane sugar has no action on this reagent; a dilute solution of sugar of milk acts the same as grape sugar.

September 18.

Pyrogallol in presence of salts of iron.—M. E. Jacquemin.—The experiments of the author contradict those which assign to pyrogallic acid the property of coloring blue the ferruginous salts.

October 2.

An **impermeable paper**, based on the solubility of cellulose in ammonio-copper solution. Treating paper with the above solution and drying it, it becomes impermeable to water, and preserves its consistence even in boiling water.

Toxic compounds of cobalt.—Mr. Sugen, who has experimented with the nitrate and chloride of cobalt, regards them as poisons, for 1 centigr. of one or the other will kill a frog in half an hour; 3 decigrm. will kill a rabbit in three hours. It appears to act directly on the muscles of the heart, the pulsations of which it retards.

Thermic researches on the **condensation of gas by solid bodies.**—Absorption of hydrogen by platinum black.—P. A. Favre.—The mode of condensation of hydrogen by platinum black differs from that of hydrogen by palladium in leaves. The heat evolved is not constant for equal weights of gas absorbed as it is with palladium. Thus 1 gramme of hydrogen produced by the electrolysis of sulphuric acid and condensed by palladium:—

The first experiment gave	8·938 calorics.
The seventeenth experiment gave	9·167 "

In the condensation of ordinary hydrogen by platinum,

The first experiment gave	23·075 calorics.
The fourth experiment gave	13·528 "

On the proportion of **carbonic acid in the air**; its variation with latitude.—P. Truchot.—Carbonic acid is in greater proportion during the night than day. De Saussure found in 10,000 volumes of air, 4 volumes during the day and 4·3 in the night; and Boussingault obtained 3·9 during the day and 4·2 during the night; it is not sensibly lighter in the city than in the country. It diminishes quite rapidly as we rise in the atmosphere.

October 9.

Anilin red.—M. Fernand Hamel has found that under the action of chloride of sulphur, anilin gives a new red coloring material. By treating this red solid with acetic acid after filtration a red liquor is obtained which gives a brilliant black product, which is soluble in acetic acid, sulphur, ether, and alcohol.

On the action of gases in the **coagulation of albumen.**—MM. E. Mathieu and V. Urbain.—When the gases dissolved in blood serum are removed, an albuminous liquid is obtained which will not coagulate even at 100°. Carbonic acid is the agent of the coagulation of blood by heat. Albumen deprived of its volatile salts, is transformed into globulin.

Production by the dry way of some **crystallized borates.**—M. A. Ditte.—He uses an equivalent mixture of alkaline chlorides, fusing at a red heat, into which he adds the amorphous borates or elements of the desired salt. Being treated in a platinum crucible by a gas lamp, the borates become crystallized in the upper part of the crucible. These are detached and treated with boiling water which dissolves the chlorides and leaves the crystals pure. He has thus produced borate of lime, of strontium, and the neutral borate of strontium.

On the **new derivatives of propyle.**—M. A. Cahours.—Oxalate of propyle is a colorless liquid represented by the formula $C_3O_6(C_6H_7O)_2 = C_{16}H_{14}O_8$. When acted on by alcoholic ammonia a beautifully crystalline substance is produced corresponding to oxamethene. It is oxalopropylic ether, $C_4H_2NO_3C_6H_7O$. Carbonate of propyle, a colorless liquid, boiled with concentrated caustic potassapropylic alcohol, is produced. In contact with ammonia it changes slowly to propylic urethane. Its composition is $C_{14}H_{14}O = C.O_4(C_6H_7O)_2$. Salicylate of propyle, produced by distilling a mixture of propylic alcohol, salicylic acid, and concentrated sulphuric acid. Its composition is $C_{14}H_5O_5C_6H_7O = C_{20}H_{12}O_6$. Phenate of propyl, whose composition is represented by $C_{12}H_5(C_6H_7)O_2 = C_{18}H_{12}O_2$. Nitrate of propyle—

$$C_6H_7NO_4 = \left.\begin{matrix} C_6H_7 \\ NO_2 \end{matrix}\right\} O_2$$

Researches on **tribromacetic acid.**—M. H. Gal.—Its mode of preparation is discussed and the composition given as C 8·7, H 0·37, Br 87·6. H. N.

Journal of the Chemical Society.

Series II. Vol. xi., November.

Œnanthylic acid and normal heptyl alcohol.—Grimshaw and Schorlemmer.—This research was undertaken for the purpose of comparing the œnanthylic acid from the oxidation of œnanthol (obtained from castor oil first by Tilley) with that obtained by Schorlemmer from normal heptane, and with the heptylic acid of Franchimont, obtained by synthesis from the hexyl alcohol from Heracleum oil. The authors prepare their acid by oxidizing the œnanthol with potassium bichromate and sulphuric acid. After purification, the acid was obtained as a limpid, oily liquid boiling at 223°–224°, with a faint odor of tallow when cold. At 10·5°, it solidified in crystalline plates. From a comparison of the acids themselves, as well as their ethyl, potassium, sodium, barium, calcium, zinc, lead, copper, and silver salts, the authors conclude that the acid from heptane is identical with œnanthylic acid; but that Franchimont's heptylic acid, though probably also a normal acid, is only an isomer of it. By the reduction of œnanthol with sodium amalgam, normal heptyl alcohol was obtained as a colorless oily liquid boiling at 175·5°–177·5°. The following normal alcohols are now therefore known:—

Name.	Boiling point.	Difference.	Observer.
Ethyl alcohol,	78·4°	——	Kopp.
Propyl "	97°–98°	19°	Diff. observers.
Butyl "	116°	18·5°	Lieben and Rossi.
Pentyl "	137°	21°	Lieben and Rossi.
Hextyl "	157°	20°	Franchimont and Zincke.
Heptyl "	175·5°–177·5°	19·5°	Grimshaw and Schorlemmer.
Octyl "	196°–197°	20°	Renesse.
Mean		19·6°	

On some oxidation and decomposition-products of **morphine derivatives.**—Mayer and Wright.—Apomorphine hydrochloride, treated with caustic potash in excess yields a colorless solution which rapidly absorbs oxygen and becomes black. Acidified with hydrochloric acid and agitated with ether, it gives to the ether a rich purple color like permanganate. After repeated solution in sodium carbonate and reprecipitation, the flakes obtained gave on analysis the formula $C_{40}H_{34}N_2O_7$.

Action of heat on **morphine derivatives.**—Mayer and Wright.—The three series of morphine derivatives, viz., the mono, di, and tetra-morphine series, differ in the way in which their hydrochlorides split up by the action of heat, the mono-series eliminating nitrogen in the form of pyridine, the di-series giving no appreciable quantity of any volatile base at 150°–180°, and the tetra-series giving methylamine under the same circumstances.

Action of silver nitrate and nitric acid on certain **morphine and codeine derivatives.**—C. R. A. Wright.—When certain bodies derived from polyme-

rides of morphine or codeine are treated with silver nitrate and nitric acid, a blood-red liquid is formed; whilst when similar derivatives containing more hydrogen than that present in the normal morphine polymeride derivatives are treated in the same way, a bright yellow liquid is obtained. The author has succeeded in isolating and analyzing these coloring matters.

Monthly analytical examinations of the **Harrowgate spas**, 1872.—R. H. Davis.

December.

Optical properties of some modifications of the **cinchona alkaloids**.—D. Howard.—The salts of ethyl-bases, in which the distinctive characteristics of the alkaloid are not lost, give a series of numbers closely resembling those representing the rotatory powers of the salts of the original alkaloids, but with somewhat lower values for the powers of the contained alkaloids. On the two other cases treated of on the other hand, where the distinctive characteristics of the isomeric alkaloids are in other respects lost also, and a new power obtained occupying a position between the former ones.

Series II. Vol. xii., January.

Preliminary notice on the **oils of wormwood and citronella**.—C. R. A. Wright.—Oil of wormwood yields, on fractional distillation, absinthol mostly at 200°–205°, and having the formula $C_{10}H_{16}O$. Heated with phosphoric sulphide, absinthol gave a distillate consisting essentially of cymene and thiocymene. Oil of citronella gives a substantive $C_{10}H_{18}O$, which on dehydration seems to give rise to a terpene.

On the action of **hydrogen on silver nitrate**.—W. J. Russell.—The series of reactions which appear to take place when hydrogen is left in contact with silver nitrate are: first, the replacement of silver by hydrogen, the silver separating out in the crystalline form; then after a certain time, by the aid of the hydrogen present, a trace of nitrous acid is probably formed, which is capable of attacking the precipitated silver and combining with it. At the same time nitric oxide is given off, which by acting on more nitric acid forms more nitrous acid, thus accelerating the solution of the silver. If much nitric acid be present, the silver nitrite naturally passes back again to nitrate, and this may again be acted on by the hydrogen. The silver nitrite, on the contrary, is unacted on by hydrogen, and will, therefore, be the end-product formed by this reaction. Platinum, palladium, and gold are precipitated, by hydrogen, and copper nitrate is converted into nitrite.

February.

Mineralogical notices, **caledonite, lanarkite**.—Story Maskelyne and Flight.—Analysis proves that caledonite does not contain carbonic acid, its composition being represented by $(PbSO_4)_5 + (CuH_2O_2)_3 + (PbH_2O_2)_2$. Lanarkite was proved also to contain no carbonic acid and to be anhydrous. The composition $PbSO_4 + PbO$ is assigned to it.

Analysis of a **meteoric stone** and the detection of **vanadium** in it.—Apjohn.—The aerolite examined fell at Adare, Ireland, in 1810. It consisted of a metallic portion 19·07, of magnetic pyrites 6·54, chromic iron 1·75, soluble silicate 35·44, insoluble silicate 37·07. Vanadium was readily detected in it.

On the action of **zinc chloride on codeine**.—C. R. A. Wright.—The base soluble in ether produced by the action of zinc chloride upon codeine, has not the composition of "apocodeine," but consists almost wholly of tricodeine, along with minute quantities of other bodies.

On the **hydrochloride of narceine**.—C. R. A. Wright.—Unless a large excess of acid be used, the narceine hydrochloride separates with less than the normal amount of chlorine, this being reduced in some cases even to 0·4 per cent. On digesting narceine with concentrated hydrochloric acid at 100° for an hour, a new base is obtained, whose chloride is $C_{23}H_{27}NO_8,HCl$, and which has no marked physiological action.

March.

Preparation of the standard trial plates, to be used in verifying **the composition of the coinage**.—Chandler Roberts.—The gold plate was prepared by melting together repeatedly pure gold and pure copper in the right proportions, and rolling out the ingot into a plate. On assaying different portions of the plate its composition was found to vary between 916·5 and 916·7 parts of fine gold in 1000, the mean variation from the standard (916·66 fine), being $\frac{1}{2500}$ of the whole mass. Owing to segregation, the preparation of the silver plate was more difficult, 1000 ounces of standard silver were cast in a plate, its entire outer surface removed, and the slab then rolled out. On assaying different portions of the plate, the silver was found to have concentrated itself in the centre. A portion on the edge was, therefore, taken as the trial plate, the mean of all the assays of which gave 924·96 as the fineness, varying from fineness by only $\frac{1}{2500}$.

On a **specific gravity apparatus** for temperature other than atmospheric.—Hannay.

On the action of the **copper-zinc couple** on organic bodies. Part iv. On iodide of allyl.—Gladstone and Tribe.—The dry couple at 100° acts on allyl iodide to produce diallyl and a non-volatile hydrocarbon $(C_3H_4)_n$. When water is present propylene is produced as follows:—

$$C_3H_5I + H_2O + Zn = ZnI.HO + C_3H_6.$$

A similar reaction takes place in presence of alcohol.

On **ferrous anhydro-sulphate**.—Bolas.—When 10 per cent. of a saturated aqueous solution of ferrous sulphate is added to strong sulphuric acid, it deposits, on cooling, a white powder consisting of minute prismatic crystals having the composition FeS_2O_7.

On **tetranickelous phosphide**.—R. Schenk.—When a solution of nickelous chloride containing tartaric acid is poured into a boiling solution of potash containing phosphorus, a black substance is obtained which when purified has the composition Ni_4P_2.

April.

On the products of decomposition of **castor oil**, No. I. Sebacic acid, No. I.—Neison.—The sebacic acid was prepared by distilling equal weights of castor oil and sodium hydrate, mixed with one-tenth of water, and purified either by partial or complete precipitation of the acid from the aqueous solution of the residue, and recrystallizing. It crystallizes in long, fine, feathery crystals, soluble in 50 parts of water at 100°, reddens litmus strongly, and is dibasic. Its salts are described in the paper.

Action of benzyl chloride on **laurel camphor** (laurus camphora) Part I. Preliminary notices.—D. Tommasi.—By distilling benzyl chloride, camphor, and powdered zinc at a gentle heat, an acid liquid comes over, which, when freed from acid by potassium carbonate and redistilled, yields several volatile products—principally toluene, boiling at 110°–112°—and a viscous liquid in the retort, yet unexamined.

Action of **triacetyle chloride upon amines**. Action upon aniline.—Tommasi.—When aniline is treated with trichloracetyl chloride in excess, hydrochloric acid is evolved, and on cooling the liquid solidifies to a mass of crystals. On analysis these crystals afforded the formula

$C_8H_6NCl_3O$ or $N\begin{cases}C_6H_5\\C_2Cl_3O\\H\end{cases}$, phenyl trichloracetamide, formed according to the equation—

$$C_2Cl_3O.Cl + N\begin{cases}C_6H_5\\H\\H\end{cases} = N\begin{cases}C_6H_5\\C_2Cl_3O\\H\end{cases} + HCl.$$

Phenyl-trichloracetamide forms lustrous crystalline plates, rhomboidal in form. Has scarcely any odor, and tastes bitter. Fuses at 94° and solidifies at 83°. Soluble in sulphuric acid, in benzene, ether, carbon disulphide. Nitric acid converts it into dinitrophenyl trichloracetamide.

Isomeric terpenes and their derivatives. Part III. On the essential oils of wormwood and citronella.—C. R. A. Wright.—This paper is a more complete statement of the results already given in the January number. Oil of wormwood begins to boil at 200° and mostly distils below 220°. On fractioning, a small quantity of a terpene $C_{10}H_{16}$ was obtained, the mass consisting of a liquid boiling at 200°–201°, and having the composition $C_{10}H_{18}O$, being isomeric with camphor and myristical. It is absinthol. Oil of citronella yielded variable distillates, mostly agreeing with the formula $C_{10}H_{18}O$, or citronellol, zinc chloride resinifies most of the absinthol, but abstracts water from the rest, yielding cymene, $C_{10}H_{14}$. Citronellol thus treated yields a mixture of hydrocarbons. Phosphoric sulphide gives with absinthol, cymene and cymyl sulphydrate; with citronellol, a terpene $C_{10}H_{16}$ and some polymers of it. Phosphoric chloride also gives a terpene with citronellol. On treatment with bromine, however, citronellol splits up and yields cymene. The cymene from both gave terephthalic acid on oxidation.

On the **perbromates**.—M. M. P. Miner.— Perchloric acid, treated with bromine, yields perbromic acid. Potassium perbromate is difficultly soluble in water and is isomorphous with the perchlorate and periodate.

On **two coals from Cape Briton**, their cokes and ashes, with some comparative analyses.—H. How.—Analyses of the whole thickness of the main seam coal at Sydney mines, and on that of the Lingan mine coal.

G. F. B.

Vierteljahreschrift für Praktische Pharmacie, von Dr. G. C. Wittstein; Band xxii.

2 Heft.

A lecture on **manna calabrina**.—Dr. Hanbury.—The lecturer states his experience in Calabria; he found that the collection of that drug is at present very small in that locality.

On the behavior of **various vegeto-alkalies** towards sugar and concentrated sulphuric acid.—X. Schneider.

On the relative distribution of **atropine** in the leaves and the roots of *Atropa belladonna*.—J. Lefort.—The writer found the leaves collected during the months of July and August richer in atropine than those collected at an earlier period of the season. The roots from two to three year old plants proved to be superior to those of older plants. The leaves are recommended for medical purposes on account of their more uniform character.

On experiments regarding the **absorption of oxygen from the air by beetles**.—W. Müller.—The author experimented with *dysious marginalus, acilius sulcatus*, and *carabus granulatus;* he noticed, among other interesting facts, that the latter could remain for sixty hours in an atmosphere of nitrogen, and yet return in a few minutes again to full activity when placed in the common air. Beetles consumed every part of oxygen from the air without dying directly.

On the diffusion of the **vapors of mercury**.—Merget.—This important investigation corrects some early statements of Faraday. It is proved that mercury evaporates even when solid, and that its vapors diffuse corresponding to the general law, which governs the motion of all gaseous bodies; mercury vapors were noticed also to pass rapidily through solids, as leaves, wood, etc. The author recommends a paper saturated with an ammoniated solution of nitrate of silver as superior to a gold leaf for the recognition of mercury vapors.

3 Heft.

On some **acride substances**.—Prof. R. Buckheim.—The author treats of that class of compounds which we find in Euphorbium, Cortex Mezerei, Radix Podophylli peltati L., Elaterium, Radix falapar, Herba Pulsatillæ, Aloe, Fructus Colocynthides, Folia Sennæ, Radix Rhei, and Cortex Frangulæ.

Communications from the Chemical Laboratory of the General Pharmaceutical Society of Austria.—Dr. R. Godeffroy.—The results of a large number of analyses of human urine, from healthy and diseased subjects, are treated of.

On **sulphoron, a substitute for sulphur**.—C. Roberts.—The writer recommends to saturate sublimated sulphur partly with sulphurous acid, and to use this product, which he calls sulphoron, instead of fine pulverized sulphur, for the destruction of vegetable and animal parasites living upon plants like vines, rosebushes, etc.

4 Heft.

A continuation of a treatise on **acride substances**.—Prof. Buckheim.—The peculiar acride compounds contained in Oleum Ricini, Olum Crotonis, Fructus Capsici, Grana Paradisi, Cardæ, Folia Toxicodendri, Radix Pimpinellæ, etc., are in detail described.

On the percentage of **aconitine** in the leaves, stems, and the flowers of Aconitum Staerkeanum, Aconitum Napellus, and Aconitum variegatum.—O. Zinoffsky.—The flowers contained always more of it than the leaves and stems.

C. A. G.

Archiv der Pharmacie.

August, 1873.

On **metachlorphenol** and its nitro-derivatives.—H. Mueller.—Metachlorphenol was formed by conducting dry chlorine into pure melted phenol. A product was obtained of oily consistency, boiling at 175·5° to 177°, and identical in its properties with the chlorphenol of Schmitt, obtained by distilling the chlorplatinate of diazophenol.

By acting on metachlorphenol with nitric acid of 1·36 sp. gr. diluted with an equal weight of water, two isomeric nitro-derivatives were obtained:—

1. Metachlornitrophenol $C_6H_4ClNO_2O$, whose melting point is 70°.

2. Metachlororthonitrophenol $C_6H_4ClNO_2O$, which melts at 110° and 111°.

The first of these is new; the second had already been discovered by Faust.

By acting on metachlorphenol with NHO_3 of 1·36 sp. gr., another nitro-derivative was formed, viz.:—

3. Metachlordinitrophenol $C_6H_3Cl(NO_2)_2O$.

This is identical with the chlordinitrophenol of Faust and Saame. Melting point is 111°.

Another nitro-derivative from metachlorphenol is:—

4. Metachlororthonitrochlorphenol, discovered by Seyferth, and melting at 125°.

From orthochlorphenol are derived—

1. Orthochlormetanitrophenol, melting at from 86° to 87°.

2. Orthochlormetanitronitrophenol, melting at 81°.

3. Orthochlormetanitrochlorphenol, melting at from 121° to 122°.

Apparatus for scientific excursions.—Ludwig Leiner.—The best kind of boxes for botanical excursions are described; also a net for long excursions, and a kind of wire portfolio, are recommended. A. P. S. S.

Berg- und Huettenmænnische Zeitung.

No. 1, 1874.

Casting of a 12,000 hundredweight anvil for the new steamhammer at the cannon foundry at Hern.—H. von Jossa.—This work, which has taken all together three years to accomplish, has one peculiarity worth mentioning, viz., it being necessary to have the most solid and densest portion of the anvil on top when completed, and this portion being at the lowest part of the casting, it was requisite to cast the anvil with a pair of gudgeons by which the anvil was turned over when finished.

Contributions to the **manufacture of salt.**—Simmersbach.—The author recommends heating the evaporating pans by steam instead of a direct fire. This latter method injures the purity and appearance of the salt. The advantages of the steam-heating process are, that as kettles are corroded and destroyed by the fire, no kettle incrustation is formed; disturbances in working are rare; the consumption of fuel is diminished; the number of workmen lessened, while the removal and drying of the salt is rendered much less difficult.

On the influence of a percentage of **chlorine on the properties of certain metals.**—C. Kuenzel.—The author found that a cupriferous nickel containing 0·13 to 0·88 p. c. Cl, was totally unsuitable for the manufacture of German silver, as it cracked on rolling. He also found that tin-plate scraps, from which the tin had been removed by hydrochloric acid, gave an inferior iron on reheating and rolling it.

It was also discovered in Belgium, that zinc made from residues containing hydrochloric acid, could not be rolled when containing 0·2–0·3 p. c. Cl.

No. 7.

On the treatment of **tin-plate scraps.**—C. Kuenzel.—The author recommends the following process: 1st. Boiling the tin-plate scraps in water, acidulated with hydrochloric and nitric acids, until the tin has been completely dissolved. 2d. Precipitating the tin from the solution containing chlorides of tin and iron, by zinc and washing the spongy tin. 3d. Dissolving the precipitated tin in hydrochloric acid and crystallizing the stannous chloride. 4th. Treatment of the iron residues. F. P.

Jahrbuch der K. K. Geologischen Reichsanstalt.

No. 3, 1873.

Hygrophilite (a new mineral of the pinite group).—H. Laspeyres.—This mineral which is found at Halle, on the Saal (Prussia), occurs massive, of a uniform light greenish-gray or mountain-green color with a slight inclination towards yellow. The mineral is translucent on the edges, dull, having a slight resinous lustre in the sun, and has an even fracture. The hardness is 2–2·5. The sp. gr. 2·67. If brought in contact with water or steam it turns white, and innumerable small scales peel off. If placed in water, the mineral opens like the leaves of a book, owing to layer after layer of the scales peeling off, and it also turns white. An analysis of the mineral gave the following result: SiO_2 48·423, Al_2O_3 32·057, FeO 3·264, CaO 1·153, M 1·718, K_2O 5·673, Na_2O 1·364, Hg_2O 9·015, total 102·666. Hygrophilite may be distinguished from all minerals allied to it by its solubility in a potash solution, and also in hydrochloric acid, by its deportment with water and steam, and by its low specific gravity. F. P.

Verhandlungen der K. K. Geologischen Reichsanstalt.

No. 12, 1873.

Analysis of igneous rocks from the East—C. von Hauer:—

	I.	II.	III.	IV.	V.	VI.	VII.
SiO_2	54·54	68·12	58·30	65·66	58·00	64·28	54·70
Al_2O_3	16·01	15·50	17·39	15·78	17·65	16·16	18·19
Fe_2O_3	2·00	....	5·47	3·25	5·98	....	6·65
FeO	3·78	3·32	0·93	0·16	0·37	4·14	0·10
CaO	5·64	0·96	5·11	2·07	4·59	3·70	4·90
MgO	4·08	trace	2·36	0·88	2·40	1·03	2·29
K_2O	4·25	5·79	4·04	5·82	4·04	5·13	5·07
Na_2O	4·32	4·31	4·35	3·77	4·98	5·66	3·04
Loss by heating (H_2O, CO_2).	6·42	1·78	2·45	3·45	3·28	1·41	5·97
Total	101·04	99·78	100·4	100·84	101·29	101·51	109·91
Sp. gr.	2·702	2·48	2·623	2·459	2·57	2·604	2·498

I. Greenstone-trachyte from Milno Mytilene.
II. Ryolite from Malido.
III. Andesite from the north coast of Mytilene.
IV. Perlite from Molivo.
V. Andesite on the road from Erissa to Zalaris.
VI. Rock on the north bay of Mytilene, N. E. of Molivo.
VII. Principal rock of the Mithalia valley.
VIII. Rock of the Elias mountain near Molivo.

F. P.

Annales des Mines.

No. 4, 1873.

Researches on **pig-irons rich in silicon.**—L. Troost and P. Hautefeuille.—These authors come to the same conclusion as Jordan with respect to the production of a siliceous pig-iron. They found that a very siliceous pig-iron could be retained at a high state of fusion in a very quiet condition when melted in a lime crucible; while ordinary pig-iron emitted sparks due to its absorption of H and CO.

No. 5.

Heat absorbed at high temperatures, by pig-iron, cinder, and steel.—L. Gruner.—This paper is far too long to be condensed, but the author arrives at the following conclusions:—

1st. The gray pig-irons do not carry with them from the furnace more than 280–285 calories, but at the top of the hearth often possess 300–310 calories.

2d. The white pig-irons contain under the same conditions of production, 20 calories less.

3d. The gray irons still retain at the point of solidification, 244–245 calories; and immediately after solidification 221–222 calories.

4th. The white irons still retain at the point of solidification 226–235 calories; and directly after solidification 192–203 calories. This would give the latent heat of the white irons as 32–34 calories, while that of the gray irons is only 23 calories; a difference which arises from the fact that the impure gray irons remain soft and half disaggregated after their solidification, while the pure irons harden at once.

5th. The heat possessed by the cinders is about $\frac{16}{10}$ of that retained by the pig-irons at the same temperatures; *e. g.*, in the case of gray irons at the moment of tapping the maximum is 500 calories, while in the case of the white irons it is 450.

6th. The latent heat of the cinders is about 50 calories.

7th. Bessemer steel gains by refining, 30 calories above the heat possessed by the pig-iron; but ordinary steel frequently possesses, when in a melted condition, but 300 calories.

8th. The quantities of heat in question agree very well with the temperatures of fusion determined by Pouillet. That is to say the white irons melt between 1050° C. and 1100°.

The gray siliceous irons melt at about 1200°.

Ordinary steel melts at about 1350° to 1400°.

And it may be added that the white irons possess when leaving the blast-furnace a temperature of 1250° to 1300°.

The gray irons 1350° to 1450°.

And Bessemer steel attains in the converter at the period of refining a temperature of at least 1500°.

On the **heating power and classification of coals.**—L. Gruner.—Of this very fine article we are only able, owing to its length, to give the concluding table:—

Classes or Types of Coals.	Percentage of coke to 100 of pure coal.	Percentage of substances volatilized per 100 of pure coal.	Nature and appearance of the coke.	Actual heating power.	Technical heating power. Water at 0° C., boiling at 112° C., per kilogramme of pure coal burnt.
				Cals.	
1st. Dry coals with a long flame . .	55 to 60	45 to 40	Pulverulent or slightly fritted.	8000 to 8500	6·70 k. to 7·50 k.
2d. Fat coals with a long flame. (Gas coals.)	60 to 68	40 to 32	Perfectly agglomerated and generally melted together, but porous.	8500 to 8800	7·60 k. to 8·30 k.
3d. Fat coals proper. (Smelting coals.)	68 to 74	32 to 26	Fused and more or less puffed up.	8800 to 9300	8·40 k. to 9·20 k.
4th. Fat coals with a short flame. (Coking coals.)	74 to 82	26 to 18	Fused compact.	9300 to 9600	9·20 k. to 10 k.
5th. Lean or anthracitic coals.	82 to 90	18 to 10	Slightly fritted, or generally pulverulent.	9200 to 9500	9 k. to 9·50 k.

F. P.

Revue Universelle des Mines.

Vol. xxxiv., No. 2.

On **phosphorus-bronze** and its chief applications.—J. Manue.—This substance has been used for making pinions and gearings, twyers, working-barrels, piston-rings, wire, cables, and plates. In addition to the original factory at Liege, in Belgium, this alloy is manufactured at Iserlohn, in Germany, London, in England, and Pittsburg, in Pennsylvania. F. P.

Zeitschrift d. Berg- und Huettenmænnischen Vereines fuer Kærnten.

No. 12, 1873.

On the **use of coke in blast-furnace practice.**—G. Kingel.—The part of this article to which we desire to call particular attention is the *size of the charges.* The author shows the great advantage of small charges over large ones for the following reasons. The small charges remain in a particular case three hours longer in the furnace than large ones, while they charge more than twice as fast in front of the twyers. The following are some of the additional advantages of small charges:—

1st. The reducing action of the ascending gases is more intense. 2d. The rapid change of the small charges prevents high temperatures, and there is consequently no opportunity for the ore to melt and scaffold the furnace. 3d. The fuel is much more effectually utilized, since by being more widely distributed a greater surface is exposed to the blast. 4th. The amount of silicon reduced will be less. F. P.

Zeitschrift fuer des Berg-, Huetten und Salinenweren in d. Preussischen Staate.

No. 3, 1873.

Notes on the **utilization of the amalgamation-residues** by the Patera Process at Guanasevi near Durango, Mexico.—Richter and Huebner.—The residues containing 3–5 ounces of Ag per cent., are ground under water and washed. They are then roasted in a reverberatory with the addition of salt. The roasted and chloridized residues are then removed to a wooden basin provided with a sieve-bottom, and there lixiviated with water in order to remove all soluble chlorides and sodium sulphate. They are then removed to a second similar basin where water is first poured over them, and are then treated with calcium hyposulphite. The dissolved silver salts are precipitated by a calcium sulphide solution and filtered over sail-cloth. The precipitated argentic sulphide is pressed into disks, then dried in a cupelling furnace, and then roasted to remove the sulphur. After this lead is added and the regular cupellation process is carried on. F. P.

La Sucrerie Indigene.

No. 13.

Purification of water intended for feeding generators.—MM. Champion and Pellet.—In using lime to precipitate the carbonate of lime held in solution as bicarbonate, it was observed that when the proportion of bicarbonate corresponds to 0·3 grm. carbonate of lime per litre, a precipitate readily forms; when, however, the amount is equivalent to only about 0·2 grm. carbonate of lime per litre, the addition of lime causes no precipitate even on agitation. The addition of pulverized limestone at once, however, effects a precipitation. The mode recommended in such a case is to add a few thousandths of finely pulverized limestone after the addition of the necessary amount of lime. The use of hydrochloric acid for the purpose of forming the more soluble chloride is objected to as uncertain in its action, and, moreover, the chloride of calcium at a certain degree of concentration may give off HCl, and attack the metallic surfaces with which it comes in contact.

No. 14.

Practical course in **sugar making.**—M. Vivien.—*Molasses.—Process for extracting sugar from molasses.*—The processes at present in use afford, out of every 100 kilos of sugar in the beets:—

Sugar of 1st run	41.03	
" 2d "	17·09	= 63·00 kilos.
" 3d "	4·88	
Sugar in the molasses or uncrystallizable syrups . . .		18·50 kilos.
Loss by transformation of sugar into various compounds . .		18·50 kilos.

Mineral salts, especially chlorides, have been thought to be the essential constituents of the molasses which

interfere with the crystallization of the sugar, but a case is quoted in which a very high yield of sugar was obtained from a crop of beets, yet the sugar contained so much potassic chloride that it had a strong saline taste. The lime salts with organic acids are really the ones which afford the greatest obstacle to crystallization. The question as to whether it pays to work the molasses for sugar is raised.

No. 15.

Methodical crystallization by rapid cooling.—M. Wackernie's patent.—The sugar of the first run is treated as usual, being finally boiled down in a vacuum pan to 42° B., when it is heated to 110° in the pan after opening the valve. The mass is then run into a refrigerating arrangement, which lowers the temperature of the whole to below 15° in four or five hours. The granulation is stated to be excellent. E. W.

RECENT CHEMICAL PATENTS.

March 24th, 1874.

148,826.—Manufacture of Oakum.—M. Howe, Boston, Mass. Pulverized chalk is sprinkled upon the steamed fibre to absorb the grease.

148,829.—Composition for Printer's Inking Rollers.—I. L. Jackson, Washington, D. C. Glue, glycerin, borax, and Japan.

148,838.—Paint Compound.—H. C. Metcalf, Woburn, Mass. Salsoda, glue, linseed oil, Japan, whiting, white lead, Rosendale cement, water.

148,849.—Process of Hardening and Toughening the Surface of Cast-iron Mould-boards, etc.—J. S. Robinson, Canandaigua, N. Y. After moulding and partial cooling, the casting is covered with charcoal and sand, and the flask again closed and left till the article is cold.

148,862.—Manufacture of White Lead.—D. K. Tuttle and J. A. McCreary, Baltimore, Md. Lead is comminuted by a steam-jet impinging upon the melted metal, and after drying, is treated with acetic acid, carbonic acid, and air.

148,910.—Composition for Coating Telegraph Wires.—A. Wilkinson, London, England. White lead, pitch (rosin or tar), Japan, shellac, tallow, naphtha, and oil.

148,972.—Composition for Covering Boilers.—C. M. O'Hara, Fall River, Mass Forms a cellular composition by mixing ashes with silicate of soda.

149,004.—Bronzing Compound.—A. Towne, Boston, Mass. Pine-pitch, balsam of fir, benzene or turpentine, sulphuric ether, and bronzing powder.

March 31st.

149,022.—Cement for Water-proofing Joints, etc.—J. Alcorn, Jr. Boston, Mass. Ground lead, manganese, litharge, boiled linseed oil.

149,038.—Method of Analyzing Soils.—A. Herbert, Chestertown, Md. The combination and application of the following nine ingredients of plant food, viz.: Acid phosphate of lime, silicate of potash, sulphate of ammonia, sulphate of lime, chloride of sodium, sulphate of magnesia, sulphate of iron, nitrate of manganese, and sulphate of alumina, or their chemical equivalents, with ten experimental plats, in the manner and for the purpose herein described, whereby I can determine with great precision and accuracy what ingredients any soil contains, and what is necessary to add in order to grow a perfect plant of any kind.

149,054.—Insect-destroying Compound.—H. C. Miller, San Francisco, Cal. Crystals of strychnine, acetic acid, oils of rhodium and anise, and water.

149,060.—Manufacture of Wood-gas.—G. Ramsdell, Detroit, Mich. Heating wood in retort, passing gaseous products through water, and then through an hydrocarbon.

149,081.—Carbonic Acid Gas Generator.—C. H. Thompson, Cleveland, Ohio. The reservoirs for the gas generating materials are connected by pipes at the top and bottom with the main tank. The latter has a gas discharge pipe at the top, and a sediment discharge pipe at the bottom.

149,097.—Compound for Purifying Water, Preventing Corrosion.—Hugh Burgess, Royer's Ford, Pa. Made by boiling vegetable substances, such as wood, with caustic or carbonated alkalies under pressure.

149,151.—Furnace for the Manufacture of Iron and Steel.—E. Peckham, Antwerp, N. Y. Ore mixed with fluxes and charcoal is roasted upon the upper hearth, then removed to the closed retort, and finally, in the state of sponge, and without exposure to the air, transferred to the press-chamber, when it is compressed into blooms.

149,165.—Isinglass in the Liquid Form.—I. Stanwood, Gloucester, Mass. Liquid isinglass, having a small quantity of alcohol mixed with it, and put up in air-tight cans.

149,207.—Apparatus for Generating Carbonic Acid.—G. D. Dow, Boston, Mass. A chamber above the generator is provided so as to collect and return any froth foaming over.

149,218.—Water-proofing Textiles and other Materials.—G. and R. Gray, New York. Collodion and a solution of india-rubber in oil Also another solution of india-rubber, collodion, zinc-white, oil, sulphate of zinc, and sulphuric ether.

149,228.—Compound for Treating Iron.—E. Kirk, Sharon, Pa. Iron, saltpetre, concentrated potash, borax, sal ammoniac.

149,240.—Manufacture of Iron and Steel.—E. Peckham, Antwerp, N. Y. Subjecting the ore to the direct action of a reducing-flame in successive chambers, at successively increased but uniformly maintained temperatures.

149,243.—Fertilizer.—C. Perry, Rochester, N. Y. Ground malt or grain, or other seeds.

149,244.—Fertilizer.—G. J. Popplein, Baltimore, Md. Tripoli and phosphate of lime.

April 7th.

149,344.—Marbling Stone.—R. P. Sause, St. Louis, Mo.

149,449.—Photographic Varnish.—P. H. Dean, Winchester, Ind. Castile soap, glycerin, alcohol, and liquor ammonia.

149,558.—Preparing Mash for Distilling.—A. Woolner, Louisville, Ky. Scalding mash a second time with boiling slop.

April 14th.

149,561.—Electric Gas-lighting Apparatus.—E. E. Bean, Boston, Mass. A small Bunsen burner near the main burner, is lighted by the electric spark when the circuit is closed and the gas turned on, and the blaze therefrom ignites the main burner, immediately after which the small burner is extinguished; all operated automatically by clock-work and pneumatic apparatus.

149,673.—Process of Manufacturing Glue.—E. Neuer, Rock Spring, Mo. Glue stocks are first soaked in lime-water, washed, steamed in a close tank, the condensed water is run off and the mass subjected to a heavy pressure.

149,701.—Extracting Oil from Cotton and other Seeds.—W. Adamson and C. F. A. Simonin, Philadelphia, Pa. By the action of hydrocarbon vapors under pressure.

149,731.—Treating Saccharine Solutions in the Manufacture of Sugar.—J. Duncan, J. A. R. Newlands and B E. R. Newlands, London, England. Separating potash and ammonia salts by tartaric acid, acid tartrates, sulphate of alumina or phosphate of alumina dissolved in sulphuric acid.

149,756.—Soap for Washing and Bleaching.—W. Johnson, New York. Treating a tallow soap with carbonic acid gas to form a neutral glycerine soap, then adding a rosin soap, borax, turpentine, ammonia, and chlorinated soda.

April 21st.

149,859.—Manufacture of Sulphate of Soda and Potassa.—J. Hargreaves and Thomas Robinson, Widnes, England. Forcing superheated sulphurous acid, air, and water vapor through chlorides of sodium or potassium.

149,974.—Electroplating with Cobalt.—G. W. Beardslee, Brooklyn.

149,978.—Manufacture of Illuminating Gas.—L. Bois, Lyons, France. By double decomposition of steam and iron and the carbonates of soda and potash.

449,979.—Manufacture of Homogeneous Steel.—O. Bolton, Jr., Allegheny, Pa. Cast-steel from pig-iron in open hearth, by addition of ore in successive quantities, and finally ferromanganese or spiegeleisen.

150,007.—Transforming Atmospheric Gases into Oxygen and Ammonia, etc.—C. M. Tessié du Motay, Paris, France. Producing ammonia and cyanogen compounds by the reaction of carburetted hydrogen upon nitride of titanum.

150,042.—Refining Iron.—W. W. Hubbell, Philadelphia, Pa. Forcing pulverized borax and nitrate of potash into the melted iron.

150,095.—Manufacture of Sulphuric Acid.—H. Sprengel, London, England. Using water, acidified water, chamber acid or nitric acid in the form of spray in the different parts of the process.

150,111.—Process of Reducing Wood to Paper Pulp.—H. Voelter and O. Meth. Zwickan, Germany. Steaming, straining, and treating with alkali and grinding.

BOOKS RECEIVED.

Valedictory Address to the Twenty-second Graduating Class of the Women's Medical College of Pennsylvania. By Rachel L. Bodley, A.M. 8vo., 15 pp. Philadelphia, 1874.

Ueber died quantitative Bestimmung des Cyankaliums in Silberbädern. By Dr. G. C. Wittstein. 8vo., 3 pp.

Extinction du Pétrole à l'aide du Chloroform. By C. Ommeganck. 8vo., 44 pp. Bruxelles, 1874.

The Coal and Iron of Southern Ohio, considered with relation to the Hocking Valley Coal Field and its Iron Ores, with notices of Furnace Coals and Iron Smelting, followed by a view of the Coal Trade of the West. By T. Sterry Hunt, LL.D., F.R.S. 8vo., 78 pp. Salem, Mass., 1874.

Determination of Phosphoric Acid in South Carolina and Similar Phosphates. By Dr. Charles U. Shepard, Jr. 8vo., 4 pp. Charleston, S. C., 1874. Printed in full in this number.

Berichte über Gruppe IV Nahrungs und Genussmittel als Erzeugnisse der Industrie-Wiener Weltaustellung, Schweiz, 1873. By Adolf Ott in Bern. 8vo., 52 pp. Schaffhauser, Switzerland, 1874.

Reden und Abhandlungen. By JUSTUS VON LIEBIG. 8vo., 334 pp. Leipzig, 1874.

Die Chemischen Reactionen der wichtigsten anorganischen und organischen Stoffe. By Dr. PHIL. GUSTAV HEPPE. Leipzig, 1874.

Geographical and Geological Surveys West of the Mississippi. 8vo., 91 pp. 1874.

Anleitung zur Analyse der Aschen und Mineral Wasser. By ROBERT BUNSEN. 8vo., 64 pp. Heidelberg, 1874.

Jahresbericht über die Fortschritte der Thierchemie. By Dr. RICHARD MALY. 8vo., 377 pp. Wien, 1874.

Report on the Effects of the Sea-water and Exposure upon the Iron Pile Shafts of the Brandywine Shoal Light-house. By Lt. Col. JOHN D. KURTZ, U. S. A, and Capt MICAH R. BROWN. Quarto, 14 pp., with Map. Engineer Department U. S. A., Washington, D. C., 1874.

Transmission of Diseases. First paper. *Consumption.* Read before the Maine Medical Association by A. C. HAMLIN, M.D. Pamphlet, 8vo., 9 pp. Bangor, 1874.

Transfusion. Read before the Maine Medical Association by A. C. HAMLIN, M.D. Pamphlet, 8vo., 14 pp. Bangor, 1874.

Theory of the Strength of Materials, illustrated by applications to Machines and Buildings. By FRANCIS L. VINTON, E M., C E., Graduate of the U. S. M. A. and of the Ecole Imperiale des Mines, Paris. Prof. Civil and Mining Engineering, School of Mines, Columbia College. 8vo., 282 pp. New York, 1874.

Interference between the Application of T. Sterry Hunt and Richard D. Williams for Letters Patent for Utilizing Tin Plate Scraps. Testimony in behalf of Thomas Sterry Hunt. Pamphlet, 8vo., 20 pp. Boston, 1874.

Addresses delivered at the Twenty-fifth Annual Commencement of the Medical Department of Georgetown University. By Prof. RALPH WALSH, M.D., J. LLEWELLIN ELIOT, M.D., and WM. H. ROSS, M.D. Pamphlet, 8vo., 31 pp. Washington, D.C., 1874

On the Spectrum of Bile. By JOHN C. DALTON, M.D. Pamphlet, 8vo., 22 pp. New York, 1874.

Hülfsbuch zur Ausführung Chemischer Arbeiten. By Dr. HUGO SCHWANERT. Pamphlet, 8vo , 260 pp. Braunschweig, 1874.

Jahresberichi uber die Fortschritte auf dem Gesammtgebiete der Agrikultur Chemie. Pamphlet, 8vo., 336 pp. Berlin, 1874.

Handbuch der Speciellen Pathologie und Therapie herausgegeben von Dr. H. v. ZEIMSSEN, Professor der Kliuischen Mèdicin in Erlangen. *Erster Band.* Oeffentliche Gelundheits-Pfege, Gewerbekrankheiten von Professor Dr. ALOIS GEIGEL, Dr. LUDWIG HIRT, Dr. GOTTLIEB MERKEE. 8vo., 564 pp. Leipzig.

A Treatise on Food and Dietetics Physiologically and Therapeutically Considered. By F. W. PAVY, M.D., F.R.S. 8vo., 474 pp. Philadelphia, Henry C. Lea, 1874.

BREVITIES.

TO RESTORE "BURNED" STEEL.—Kulicke, of Berlin, recommends the use of a mixture having the following composition: 180 grms. tartaric acid, 900 grms. cod-liver oil, 60 grms. charcoal powder, 240 grms. bone-black, 300 grms. beef tallow, 150 grms. potassic ferrocyanide, and 90 grms. burned horn. These ingredients are thoroughly mixed, and the steel, after being heated to cherry-red heat, is hammered on an anvil, and then dipped in the mixture, and afterward in water. The results are said to be very good. For case-hardening, the same chemist recommends the use of a mixture of 10 buckets of urine, 2·5 kilos. chalk schlamm (schlammkreide), and 2 kilos. salt. Articles of soft steel heated to a red heat and plunged into this mixture, and then cooled, were found to be well case-hardened. On attempting to use this for large articles, however, an unendurable stench was caused, which drove the workmen from the workshop.

WOOD SATURATED with paraffine or paraffine-oil is well suited for railroad use, and can also replace lead in sulphuric acid works in many cases, *e. g.*, for transporting acid in casks. The paraffine is dissolved in kerosene, petroleum, ether, etc

THE FOLLOWING ENAMEL for copper cooking vessels is recommended: 12 parts of fluor-spar, 12 of raw gypsum, and 1 of borax fused together, crushed to a pasty mass, painted with a brush over the copper, dried, and then brought to a state of fusion in a muffle.

COMBINATIONS OF HYDROGEN WITH THE ALKALI METALS. — Troost and Hautefeuille.—The authors' researches have established the fact that hydrogen forms definite combination with potassium having a metallic lustre, or whose composition is represented by K_3H(K = 39), and that hydrogen forms with sodium a corresponding compound Na_2H.

Potassium may be melted in an atmosphere of hydrogen without being attacked by the gas. It—the gas—is slowly absorbed at 200°, and much more rapidly at 350° to 400°.

One volume of potassium absorbs 126 vols. of hydrogen; theory requires 124·6.

Sodium does not absorb hydrogen till the temperature reaches 300°. One volume of sodium takes up 237 volumes of hydrogen; theory requires 238.

Lithium heated at 500° absorbs 17 volumes of hydrogen. Thallium 3 volumes.

COMPOSITION OF CHINESE AND JAPANESE BRONZES.—Morin.—The author gives minute analyses of some Chinese and Indian bronzes exhibited at the Palais d'Industrie in 1869. The two samples analyzed gave—

Tin	2·64	7·27
Copper	71·46	83·09
Lead	20·31	9·90
Iron	1·73	·25
Zinc	6·00	·50

All contained traces of gold, nickel, arsenic, and sulphur.—*Comptes Rendus.*

NEW PHOTOGRAPHIC SPECTROSCOPICAL OBSERVATIONS.—Professor Vogel. —Dr. Vogel has observed that not only pure bromide, but also iodide and chloride of silver, are by far more sensitive to the blue, green, yellow, and red rays than hitherto alleged.

If the slit of the spectroscope be opened to 0·25 or 0·3 millimetre, and if the exposure is long enough, the three bodies are indeed sensitive to nearly all the rays of the spectrum. The least to the extreme red rays, and most to the indigo rays.

Pure dry iodide of silver is only slightly sensitive, but under nitrate is more sensitive to ultra-violet and indigo than the dry iodide. The sensitiveness increases from violet to indigo; but near the -G- of Fraunhofer it diminishes suddenly, and the other colors act very forcibly.

Chloride of silver, colored with naphthalene red, gives a curious result. It becomes most sensitive for yellow rays, less for red, and the least for blue. If it were possible to make chloride of silver more sensitive, the colored salt would be the very body for taking pictures in colors.

GUANO DEPOSITS OF PERU.—Commander Cookson, of the British frigate Petrel, has lately furnished the Admiralty with a somewhat remarkable report on the guano deposits of Peru. He estimates the entire quantity in the districts which he visited, viz., Huanuillos, Punta de Lobos, and Pabellon de Pica, at 7,400,000 tons. From information gathered by Commander Cookson, he is disposed to think that these deposits have not necessarily taken the enormous period of years in being formed which is commonly supposed. A native resident at Pabellon de Pica for more than forty years told him that when he first came there the whole promontory was covered with birds in countless numbers; but that about twenty-six years ago a plague visited them, and they died literally by millions. Since that time they have almost disappeared from the locality. They were chiefly pelicans, gannet, and a species of tern. It is a common remark on the coast that all birds are rapidly becoming scarce.

LAFAYETTE COLLEGE.—At a recent meeting of the Board of Trustees of Lafayette College, Dr. T. M. Drown, of Philadelphia, was elected to the chair of analytical chemistry. Dr. Green has occupied the chair of chemistry for forty years, and wishes to be relieved from the position on account of increasing duties. He will probably retain the professorship of general chemistry.

"A LITTLE LEARNING IS A DANGEROUS THING"—We call our readers' attention to Patent 149,038 in our list of "Recent Chemical Patents." Poor Liebig, how he would have rejoiced to see this day!

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—*Twenty-third Meeting, to be held at Hartford, Connecticut, August, 1874.*—In accordance with the vote of the Association at the Portland Meeting, accepting the invitation from Hartford, the Twenty-third Meeting of the Association will be held at Hartford, Connecticut, commencing at 10 o'clock A. M., on Wednesday, the 12th day of August, 1874.

The Committee appointed at the Portland meeting to secure an Act of incorporation for the Association have secured the passage of "An act incorporating the American Association for the Advancement of Science" by the Legislature of Massachusetts, and as one of the provisions of the act requires that two of the named corporators shall send a notice to each member of the Association, that the act will be presented to the Association at its next meeting, to take action thereon, the undersigned, as two of the named corporators, hereby give notice to that effect.

JOSEPH LOVERING,
JOHN L. LE CONTE.

Officers of the Hartford Meeting.—President—Dr. J. L. Le Conte, of Philadelphia, Pa.; Vice-President—Prof. C. S. Lyman, of New Haven, Conn.; Permanent Secretary—Mr. F. W. Putnam, of Salem, Mass.; General Secretary—Dr. A. C. Hamlin, of Bangor, Me.; Treasurer—Mr. William S. Vaux, of Philadelphia, Pa.

Standing Committee.—Ex-President—Prof. Joseph Lovering, of Cambridge, Mass.; Ex-Vice-President—Mr. A. H. Worthen, of Springfield, Ill.; Ex-General Secretary—Prof. C. A. White, of Brunswick, Me.; President, Vice-President, Permanent Secretary, General Secretary, and Treasurer of the Hartford meeting.

To this number there will be added six members elected from the Association at large on the first morning, and the Permanent Chairmen of the Sections.

The new draft of the Constitution proposed at Portland will be acted upon at the Hartford meeting, and should it be accepted by the Association, there will be a slight change in the Standing Committee, which would then consist of all the Past Presidents as permanent members of the Committee; the two Vice-Presidents (corresponding to the present Permanent Chairmen of the Sections) and the Secretaries of the two Sections, in addition to the officers above named.

S. P. SADTLER, Ph.D., has been elected Professor of General Chemistry in the University of Pennsylvania.

THE AMERICAN CHEMIST.

Vol. V. Nos. 2, 3.

1774.—CENTENNIAL OF CHEMISTRY.—1874.

A meeting to celebrate the Centennial of Chemistry was held at Northumberland, Pa., on July 31st and Aug. 1st. It originated in the following communication from H. Carrington Bolton, Ph.D., which was published in this journal, April, 1874, p. 362.

Centennial of Chemistry, 1774–1874.

To the Editors of the American Chemist:—

Dear Sirs: The year 1774 was rendered memorable by great chemical activity. It is not possible to assign to Chemistry any definite birth-year, but so many remarkable discoveries were made in 1774 that we may, with good reason, date the foundation of modern chemical science from that period.

It would be quite foreign to the object we have in view to give here any detailed account of the state of the science at the period referred to. We may mention, however, a few of the most important discoveries which made the year 1774 noted in the annals of Chemistry.

The eminent Swedish chemist, Scheele, first isolated chlorine, calling it, in accordance with the accepted theories of the day, "dephlogisticated muriatic acid." He also recognized baryta as a peculiar earth, and it henceforth took a place among the elementary substances. Scheele also published in this same year his masterly essay on Manganese.

Lavoisier was engaged in an investigation of the cause of the increase in weight of tin when calcined in close vessels—a research which led him to subsequent discoveries of immense importance.

Wiegleb proved alkalies to be true natural constituents of plants. Cadet described an improved method of preparing sulphuric ether. Bergman showed the presence of carbonic acid in lead white. On the 27th of September in this year Comus reduced the "calces" of the six metals by means of the electric spark, before an astonished and delighted audience of savants. On the first of August, 1774, Priestley discovered oxygen, the immediate results of which were the overthrow of the time-honored phlogistic theory and the foundation of Chemistry on its present basis.

It surely requires no lengthy argument to prove that the year 1774 may well be considered as the starting-point of modern Chemistry.

Now, Messrs. Editors, I propose that some public recognition of this fact should be made this coming summer. Would it not be an agreeable event if American chemists should meet on the first day of August, 1874, at some pleasant watering-place, to discuss chemical questions, especially the wonderfully rapid progress of chemical science in the past hundred years?

Centennial celebrations are now in order. The Bostonians have renewed the memories of the Boston Tea-Party. Already the country resounds with preparations for a National Centennial in 1876. Why should not chemists meet to enjoy a social reunion in commemoration of events important alike to science and civilization? Should this proposed meeting receive your approbation, have the kindness to offer suggestions as to the proper method of bringing it before the scientific portion of the community. Details as to the place, etc., will naturally be deferred for the present.

Very truly yours,

H. Carrington Bolton.

School of Mines, Columbia College.

Editorial Remarks.—This suggestion meets our hearty approval, and we hope that chemists who take an interest in the suggestion will send us their views at once, that the project can be put into a practical form in time for the season of summer vacations.—Editors Am. Chem.

The project was very favorably received, as is shown by letters received from several chemists: Profs. E. N. Horsford, S. Dana Hayes, Albert R. Leeds, Rachel L. Bodley, B. Silliman, T. Sterry Hunt, and others. The suggestions of Prof. Bodley determined the location of the meeting at Northumberland; they were contained in the following communication:—

Woman's Medical College of Pennsylvania,
Philadelphia, May 1, 1874.

Prof. C. F. Chandler:—

Dear Sir: I am a subscriber to your excellent journal, the American Chemist, and had therefore read in its columns the "Centennial of Chemistry," which reached me this morning in the shape of a circular. Thanks for this generous recognition of a lady professor of chemistry. At the moment I was enveloping to you a copy of a recent valedictory address, in which I referred to the Centennial year of Chemistry. Now, for my suggestion as to a locality for the proposed celebration. I made a pilgrimage last August to the grave of Priestley, in Northumberland, Pa., and was deeply impressed by the locality, its associations, and its charming surroundings; my proposition is, therefore, that the centennial gathering be around this grave, and that the meetings, other than the open-air one on the cemetery hill-top, be in the quaint little church built by Priestley, where might be exhibited the apparatus devised by the great scientist, and used in his memorable experiments. I need not remind you how convenient this locality is to the routes of summer tourists, and how centrally located for those coming from the west as well as for those residing near the seashore. . . . .

Respectfully yours,

Rachel L. Bodley,

Professor of Chemistry.

In the Valedictory Address before the 22d Graduating Class of the Woman's Medical College, Pa., March

13, accompanying this letter, Professor Bodley uses these words:—

"*Apropos* of the pleasant hours spent together in lecture-room and laboratory, let me remind you that Chemistry holds a centennial next August beside an honored grave at the meeting of the waters of the Susquehanna, amid the picturesque scenery of interior Pennsylvania. The hand that plunged the glowing taper into the primal jar of dephlogisticated air long since crumbled into dust beneath that simple headstone, but science will not forget, through centuries to come, the historic receiver, burning lens, and taper, neither willingly let die the name of Priestley, who, in August, 1774, discovered oxygen."

At a meeting of the Chemical Section of the N. Y. Lyceum of Natural History, May 11, 1874, President J. S. Newberry, LL.D., in the chair, the subject of a chemical centennial was discussed, and, on motion of Dr. H. C. Bolton, the following resolutions were adopted:—

Whereas, the discovery of oxygen by Joseph Priestley on the 1st of August, 1774, was a momentous and significant event in the history of chemistry, being the immediate forerunner of Lavoisier's generalizations on which are based the principles of modern chemical science; and

Whereas, a public recognition of the one hundredth anniversary of this brilliant discovery is both proper and eminently desirable; and

Whereas, a social re-union of American chemists for mutual exchange of ideas and observations would promote good fellowship in the brotherhood of chemists: therefore

Resolved, That a committee of five be appointed by the chair, whose duty it shall be to correspond with the chemists of the country with a view to securing the observance of a centennial anniversary of chemistry during the year 1874.

President J. S. Newberry subsequently appointed the following committee: Dr. H. C. Bolton, Prof. C. F. Chandler, Prof. Henry Wurtz, Prof. Albert R. Leeds, Prof. Chas. A. Seeley.

By this committee the centennial was organized, and the following call was issued:—

Circular from the General Committee.

To the Chemists of America:—

The year 1774 was rendered memorable by the discovery of oxygen by Joseph Priestley, by researches on chlorine by Scheele, and by important investigations undertaken by Lavoisier, which eventually led to the overthrow of the phlogistic hypothesis; the most important link in the chain having been contributed on the first of August, 1774, by Dr. Priestley.

The one hundredth anniversary of Priestley's brilliant discovery, now drawing rapidly near, is worthy of a commemorative ceremonial; and the fact, that this illustrious man spent the last years of his fruitful life in this country, renders the recognition of his work by American chemists peculiarly appropriate.

A reunion of American chemists for mutual exchange of ideas and observations would, it is believed, foster a feeling of fraternity among us, and is considered by the undersigned eminently desirable. The approaching centennial affords a fitting occasion for such a gathering. We therefore invite the chemists of America to meet at Northumberland, Pennsylvania, where Priestley lies entombed, on the 31st of July, 1874, to celebrate by appropriate exercises this memorable epoch in the history of chemistry. Signed,

George F. Barker, University of Pennsylvania, Philadelphia, Pennsylvania.
Frederick A. P. Barnard, Columbia College, New York.
James C. Booth, United States Mint, Philadelphia, Pennsylvania.
George J. Brush, Sheffield Scientific School of Yale College, New Haven, Connecticut.
George C. Caldwell, Cornell University, Ithaca, New York.
Charles F. Chandler, School of Mines, Columbia College, New York.
William H. Chandler, Lehigh University, Bethlehem, Pennsylvania.
Josiah P. Cooke, Jr., Harvard University, Cambridge, Massachusetts.
Henry H. Croft, University College, Toronto, Canada.
Silas H. Douglas, University of Michigan, Ann Arbor, Michigan.
Henry Draper, University of the City of New York.
John C. Draper, College of the City of New York.
John W. Draper, University of the City of New York.
Frederick A. Genth, University of Pennsylvania, Philadelphia, Pennsylvania.
Wolcott Gibbs, Harvard University, Cambridge, Massachusetts.
Charles A. Goessmann, Massachusetts Agricultural College, Amherst, Massachusetts.
S. Dana Hayes, State Assayer, Boston, Massachusetts.
Benjamin S. Hedrick, Patent Office, Washington, D. C.
Joseph Henry, Smithsonian Institution, Washington, D. C.
Eugene W. Hilgard, University of Michigan, Ann Arbor, Michigan.
Eben N. Horsford, Cambridge, Massachusetts.
T. Sterry Hunt, Massachusetts Institute of Technology, Boston, Massachusetts.
Samuel W. Johnson, Sheffield Scientific School of Yale College, New Haven, Connecticut.
Charles A. Joy, Columbia College, New York.
H. L. Kendrick, United States Military Academy, West Point, New York.
Albert R. Leeds, Stevens Institute of Technology, Hoboken, New Jersey.
Abram Litton, St. Louis Medical College, St. Louis, Missouri.
John W. Mallet, University of Virginia, Virginia.
Henry Morton, Stevens Institute of Technology, Hoboken, New Jersey.
Henry B. Nason, Rensselaer Polytechnic Institute, Troy, New York.
John M. Ordway, Massachusetts Institute of Technology, Boston, Massachusetts.

Ira Remsen, Williams College, Williamstown, Massachusetts.
Robert E. Rogers, University of Pennsylvania, Philadelphia, Pennsylvania.
Charles A. Seeley, New York City.
Benjamin Silliman, Yale College, New Haven, Connecticut.
J. Lawrence Smith, Louisville, Kentucky.
Henry Wurtz, Hoboken, New Jersey.

Communications should be sent to

H. Carrington Bolton,
Chairman of the General Committee,
School of Mines, Columbia College, New York.

Information.

Northumberland is situated at the junction of the North and West Branches of the Susquehanna River, about sixty miles north of Harrisburg. The scenery in this region, always picturesque, is at this point exceedingly beautiful, and those visiting Northumberland will be fully repaid by the beauties of Nature alone. A short distance from the town, in a hillside cemetery, charmingly located, lie the remains of Joseph Priestley; the house he built, and in which he died, is in perfect preservation; many relics of him are found in the town; here, too, dwell his descendants, who honor and revere his name. These and other considerations influenced a majority of the committee to call the meeting at Northumberland; here, then, let those gather who are willing to pay a tribute to the memory of the good and great man who laid the corner-stone of chemical science.

The memorial exercises have not been definitely arranged; but it is expected that they will include—

I. An Address by Professor Joseph Henry.
II. A Sketch of the Life and Labors of Joseph Priestley, by Professor Henry H. Croft.
III. A Review of the Century's Progress in Theoretical Chemistry, by Professor T. Sterry Hunt.
IV. A Review of the Century's Progress in Industrial Chemistry, by Professor J. Lawrence Smith.
V. An Essay on American Contributions to Chemistry, by Professor Benjamin Silliman.

Detailed programmes of the exercises will be in readiness for distribution at the meeting.

In order to add to the interest of the occasion, a Loan Exhibition will take place during the meeting for displaying apparatus, books, manuscripts, etc., belonging to Dr. Priestley, or other objects illustrating the history of chemistry. Gentlemen receiving this circular are earnestly requested to contribute anything in their possession appropriate to this Loan Exhibition.

Local Committee.

Joseph Priestley, M. D., *Chairman.*
Robert B. McCay, M. D., *Secretary.*

Rev. C. G. Adams,
Joseph Bird,
J. H. Jenkins,
William G. Greenough,
Simon Randall,
G. R. Vanallen,
} *Executive Committee.*

Rev. E. E. Berry.
Rev. H. D. Catlin,
John T. Colt,
James G. Dieffenbacher,
William Everard,
Rev. Horatio H. Hewitt,
Rev. James Hunter,
Reuben Johnson,
J. S. Mourer, M. D.,
M. B. Priestley,
David Reimer,
Col. David Taggart,
M. J. D. Withington,
Frederick Burkenbine,
D. M. Brautigam,
J. W. Cook,
A. E. Kapp,
William Elliott,
William T. Forsyth,
Alfred Hawley,
C. Lenker,
Rev. A. D. Moore,
A. G. Postlethwait,
Anthony C. Simpson,
Zachary Taylor,
Cornelius G. Vanallen.

Report of the Meeting.

On Thursday, July 30, the chemists began to arrive. The following is an alphabetical list of the chemists who attended the celebration, as far as I have been able to procure their names.

C. S. Allen, New York.
B. G. Amend, New York.
H. C. Bolton, Ph.D., School of Mines, Columbia College.
P. W. Bedford, M.D., New York College of Pharmacy, New York.
J. L. Breeze, New York.
A. A. Breneman, Agricultural College of Penna., Pa.
Miss E. T. Capen, High School, Boston, Mass.
C. F. Chandler, Ph.D., School of Mines, Columbia College.
W. H. Chandler, Ph.D., Lehigh University, Bethlehem, Pa.
H. H. Croft, University College, Toronto, Canada.
J. B. Crowell, M.D., Presbyterian Hospital, N. Y.
E. T. Cox, State Geological Survey, Indianapolis, Ind.
F. W. Clarke, Ph.D., University of Cincinnati.
H. Coppee, LL.D., Lehigh University, Bethlehem, Pa.
E. B. Cox, M.E., Drifton, Pa.
J. A. Church, M.E., New York.
C. H. Chandler, Antioch College, Yellow Springs, Ohio.
T. M. Drown, Ph.D., Lafayette College, Pa.
S. H. Douglass, Ph.D., University of Michigan, Ann Arbor, Mich.
A. G. Day, New York.
W. W. Daniels, Madison, Wis.
A. H. Elliott, Baltimore, Md.
H. Endeman, Ph.D., Health Department, New York.
E. T. Fristoe, LL.D., Columbian University, Washington, D. C.
P. Frazer, Jr., Ph.D., University of Pennsylvania, Philadelphia, Pa.
J. Fretwell, Jr., London, England.
W. Falke, New York.
G. H. Fortney, A.B., Selins Grove, Pa.
Traill Green, M.D., Lafayette College, Easton, Pa.
J. Emery, Williamsport, Pa.

A. H. Gallatin, M.D., Cooper Institute, N. Y.
S. A. Goldschmidt, M.E., Savannah, Ga.
Eben Hunt, A.M., Chester, Pa.
E. N. Horsford, Cambridge, Mass.
F. Hoffman, Ph.D., New York.
T. S. Hunt, LL.D., Mass. Inst. Techn., Boston, Mass.
E. W. Hilgard, University of Michigan, Ann Arbor, Mich.
A. C. Hale, Jersey City.
B. S. Hedrick, U. S. Patent Office, Washington, D. C.
E. J. Hallock, Columbia College, New York.
W. Malvern Iles, N. Y.
C. A. Joy, Ph.D., Columbia College, N. Y.
W. K. Kedzie, State Agricultural College, Manhattan, Kansas.
R. C. Kedzie, M.D., Lansing, Mich.
R. S. Kenderdine, M.D., Philadelphia, Pa.
L. H. Laudy, School of Mines, Columbia College, N. Y.
A. R. Leeds, Ph.D., Stevens Institute of Technology, New Jersey.
W. G. Levison, Brooklyn, N. Y.
J. Macfarlane, Towanda, Pa.
Arthur Macy, New York.
J. W. Mallet, Ph.D., University of Virginia.
J. M. Maisch, College of Pharmacy, Philadelphia, Pa.
S. G. Morrison, Williamsport, Pa.
H. B. Nason, Ph.D., Rensselaer Polytechnic Institute, Troy, N. Y.
J. W. Osborne, Washington, D. C.
Rev. Dr. T. R. Pynchon, Trinity College, Hartford, Conn.
Wm. Richardson, Cooper Institute, New York.
J. P. Remington, College of Pharmacy, Philadelphia.
C. W. Roepper, Bethlehem, Pa.
Miss Ellen H. Swallow, B.S., Boston, Mass.
S. P. Sharples, S.B., Boston, Mass.
Benjamin Silliman, M.D., LL.D., Yale College, New Haven, Conn.
J. Lawrence Smith, Ph.D., Louisville, Ky.
A. P. S. Stewart, Indust. University of Illinois, Champaign, Ill.
Samuel St. John, M.D., College of Physicians and Surgeons, N. Y.
C. A. Sniffin, New York.
H. G. Torrey, U. S. Assay Office, New York City.
Milton S. Thompson, Islip, L. I.
W. H. S. Thorburn, New York.
W. H. Taylor, M.D., Richmond, Virginia.
P. H. Vander-Weyde, M.D., New York.
T. G. Wormley, Ph.D., LL.D., Columbus, Ohio.
C. G. Wheeler, University of Chicago.
A. W. Wright, University of Cincinnati.
E. Waller, E.M., School of Mines, Columbia College, New York.
T. S. Weirman, C.E., Harrisburg, Pa.
E. L. Youmans, New York.

The meeting was graced by the presence of numerous ladies, including the wives and daughters of many of the chemists present.

The following is a brief summary of the proceedings of the meetings:—

PROCEEDINGS OF THE CHEMICAL CENTENIAL AT NORTHUMBERLAND.

Secretary's Report.

A magnificent unclouded day rejoiced the chemists who had assembled at Northumberland, Pa., on the morning of the 31st of July, 1874. Promptly at 9 o'clock the large lecture room in the upper story of the fine public school building was crowded, and after a few minutes of anticipation, the meeting was temporarily organized for business by the appointment of Dr. H. Carrington Bolton, temporary chairman. On motion of Prof. E. N. Horsford, a nominating committee was appointed composed of Prof. E. N. Horsford, Dr. Albert H. Gallatin, Prof. A. P. S. Stuart, Dr. P. H. Vander-Weyde, Elwyn Waller, Prof. S. St. John.

They reported the following list of permanent officers, which was adopted by the meeting:—

PRESIDENT,

Prof. Charles F. Chandler.

VICE PRESIDENTS,

Prof. Rachel L. Bodley,
Prof. John W. Draper,
Prof. Silas H. Douglas,
Dr. Albert H. Gallatin,
Prof. Eugene W. Hilgard,
Prof. E. N. Horsford,
Prof. J. W. Mallet,
Prof. S. St. John,
Prof. A. P. S. Stuart,
Prof. T. G. Wormley,
Prof. Henry Wurtz,
Prof. C. A. Joy,
Dr. H. Carrington Bolton.

SECRETARY,

Prof. Albert R. Leeds.

TREASURER,

Prof. William H. Chandler.

FINANCE COMMITTEE.

The Treasurer, Prof. T. R. Pynchon, Prof. Traill Green, Prof. A. P. S. Stuart, Prof. H. Wurtz, Prof. Persifor Frazer, Prof. B. S. Hedrick.

COMMITTEE ON RESOLUTIONS.

Prof. B. Silliman, Prof. J. W. Mallet, Prof. J. Lawrence Smith, Prof. Wm. H. Chandler.

COMMITTEE ON SCIENTIFIC PAPERS.

Prof. C. A. Joy, Dr. T. M. Drown, Prof. F. W. Clarke.

COMMITTEE ON TELEGRAMS.

Prof. Persifor Frazer, S. P. Sharples, and Prof. C. Gilbert Wheeler.

On motion of Prof. J. Lawrence Smith, a committee consisting of Prof. J. L. Smith, Prof. E. L. Youmans, and Prof. C. A. Joy was afterwards appointed, in addition to the above, to represent America in spirit at the unveiling of the Priestley statue on August 1st, at Birmingham, England.

At the conclusion of the reading of the list of officers, Dr. Bolton called upon Dr. Joseph Priestley to conduct the president to the chair.

After a few introductory remarks the president announced Col. David Taggart of Northumberland, who delivered the address of welcome.

Address of Welcome by Col. David Taggart of Northumberland, Pennsylvania.

I have been chosen by my fellow-citizens to offer to the learned and distinguished men and women who

have gathered here to commemorate a grand discovery, and to honor a great name, a very brief but earnest welcome. We cannot follow you through the wide realms of science, nor penetrate very deeply the mysteries of nature, for we know more about oxen than oxygen, and a great deal more about the whey of milk than the Milky Way; but we can move with equal step in paying tribute of respect and reverence to the illustrious man, who eighty years ago found among "the rude forefathers" of this hamlet a quiet home, and seventy years ago an honored grave.

While in the lapse of everlasting time all human names must be forgotten, many ages will have come and gone, and left their silent footmarks on the earth, before the name of Priestley will pass from the memories and the records of his fellow-men. He has written it in letters of light and glory upon the highest, broadest pillar of the universe. By right of genius and labor he takes rank with "the dead but sceptred sovereigns who still rule our spirits from their urns."

Like the eagle, he built his eyry upon the mountain top, inaccessible to vulgar intrusions. In that pure atmosphere he dwelt, not above human spite, jealousy, and detraction—for it is easier to get below than above them—but above their annoyances. The shafts of bigots and fools were aimed at him, but they could not penetrate the triple armor which Philosophy, Enthusiasm, and Truth had thrown around him. Like you, gentlemen, he made Science his mistress, and with a pure heart and an untiring mind, he worshipped her "through long days of labor, and nights devoid of ease." And to-day he stands with Galileo, Newton, Harvey, Franklin, Faraday, and Humboldt, grand, colossal, and enduring; one of the great high priests in the boundless and beautiful temple of Nature.

A brutal English mob could burn his dwelling, and in an hour of political madness and religious frenzy destroy the work of years, but it could not stay the indomitable energy of his genius, nor dim the lustre of his brain-won renown. While the miserable wretches who composed that mob have long ago given back to the great element which he discovered 75 per cent. of their worthless carcasses, more than eighty years afterwards his great name is a talisman to draw to this quiet village many of the most renowned knowledge-gatherers of the nation—besides several from New Jersey and Canada—an aristocracy of learning and intellect that can afford to look down from its high citadels of thought and achievement with pity, if not contempt, upon the mere vulgar aristocracy of blind accident—the painted caterpillars of pretentious illiterate wealth.

As I am not vain enough to suppose that any one cares to listen to me when such illustrious names are upon the bills, I will merely reiterate to you, men and women of sense and science, in behalf of all my neighbors, a very sincere and unfeigned welcome to our homes and to our hearts. And let me assure you most earnestly, that we are not only willing but anxious to do all things possible to make you remember with pleasure your well-timed pilgrimage to the home and grave of the greatest discoverer of his time.

President Chandler replied, returning thanks, on behalf of the chemists, to the citizens of Northumberland, for their liberal hospitality.

Letters and telegrams were read from Dr. John W. Draper, Prof. Joseph Henry, Prof. Benjamin Silliman, Prof. S. Dana Hayes.

Letter from Dr. John W. Draper.

University of New York, July, 1874.

Dr. H. Carrington Bolton:—

My Dear Sir: I cannot feel satisfied by merely saying that unavoidable circumstances prevent me from joining you on this occasion. No one would more sincerely do honor to the memory of Dr. Priestley, or more readily make a pilgrimage to his grave.

In my boyhood I learned to revere his name. When I was seven or eight years old, I went to school at Nantwich, a town in which he had formerly taught, and where his memory still survived. I often heard of the wrongs he had endured and of the distinction he had achieved.

Driven from his native country by public injustice, what a lesson does his example offer to us! He manfully upheld what he believed to be the truth at the risk of all that was dear to him, even at the peril of his life. But posterity, to whom he entrusted his cause, has vindicated him at last. In the summer of 1860, when the British Association met at Oxford, I witnessed the inauguration of a statue raised to his memory in the corridor of the museum of that university, Oxford of old, the focus of many of those theological views that he so strenuously combated. And now Birmingham, in which his laboratory was destroyed, his house burned, and the records of the labors of many years consumed, in that very town from which he had to flee for his life, an expiatory statue is about to be raised.

If it be given to the dead to know what is passing here, how impressive in this presence are these statements—how solemn this communion at Priestley's grave!

What an amazing change the world has witnessed since Priestley's discovery of oxygen gas—a change to no insignificant degree due to that revolution in chemistry which he inaugurated. He set sail from England on the 8th of April, 1794, and arrived in New York on the 4th of June. His voyage occupied almost exactly eight weeks. Now the steamships are making it in less than eight days.

In your circular you mention, for the information of those who desire to join you, the numerous railways by which they may reach Northumberland from all directions. This recalls to my mind a passage in Dr. Priestley's autobiography, in which, justifying his selection of that town as his residence, he very plaintively says that he hopes after some time a readier communication will be opened with Philadelphia.

How little did he foresee that vast network of railways now binding the continent together—how little the grand iron road that connects the Atlantic and Pacific! Yet these and the locomotives that run over them owe their existence to that chemistry which he did so much to develop.

Not only in the physical but also in another direction there has been a great social improvement since Dr. Priestley's time. He was refused by the Board of Longitude an astronomical appointment in Captain Cook's second expedition in 1772, on account of his religious opinions. In the numerous and costly national scientific expeditions at present on their way for observing the coming transit of Venus, probably in not a single instance has inquiry been made as to the religious opinions of the observers. Such expeditions are looked upon now, as he insisted they should have been looked upon then, "a business of philosophy, not of divinity." And yet how little can men foresee their best interests! Had the Board of Longitude been less bigoted, had they not refused him permission to go with Cook, he would have missed his greatest glory, that great discovery which you are commemorating to-day—the discovery of oxygen

gas. During his absence in the South Sea, it would have been left to Scheele, his illustrious Swedish competitor.

Once more let me express my regret that I am prevented from joining you on this occasion of commemorating what we all look upon as the most important discovery in our science, and of rendering homage to its great author.

Very respectfully yours,
John W. Draper.

Letter from Professor Henry.

Smithsonian Institution, Washington, D. C.,
30th July, 1874.

Dr. H. Carrington Bolton:—

My Dear Sir: I regret very much to be obliged to inform you that I cannot be present at the very interesting ceremony which takes place to-morrow at Northumberland, on account of temporary illness induced by the late hot and changeable weather. I have, in part, prepared an address to be delivered, which, however, I think will not be missed amid the number of communications which will be presented.

I beg to assure you that it would have given me much pleasure to have been present on this interesting occasion, and to have added my tribute to the great and good man whose life and labors are simultaneously to be commemorated on both sides of the Atlantic.

I remain yours, truly,
Joseph Henry.

The Committee on Telegrams reported the following telegram, which was approved and ordered to be sent to Birmingham at such time as would render it most likely to reach the chemists there assembled while in session.

Telegram to Birmingham.

"Northumberland, Pa., July 31, 1874, 10 A. M.

"To the Priestley Memorial Committee, Birmingham, England:—

"The brother chemists at the grave, to their brothers at the home of Priestley, send greeting on the centennial anniversary of the birth of Chemistry."

"Committee on Telegrams."

A cable dispatch from Birmingham, received at Northumberland, 10.15 A. M., July 31, 1874, was read.

Telegram from Birmingham.

"To the American Chemists assembled at Northumberland, Pa.:—

"Our marble statue, representing Priestley discovering oxygen, will be unveiled to-morrow. Presented by the subscribers, through Professor Huxley, to the town, and accepted by the mayor. We greet you as colleagues engaged in honoring the memory of a great and good man.

"The Priestley Memorial Committee of Birmingham."

Prof. J. Lawrence Smith suggested, that, inasmuch as many great chemical discoveries were made in the year 1776, and about that time the discoveries of Priestley, Scheele, and Lavoisier produced their first practical effects, it would be appropriate that a world's centennial of chemists should be called in that year, especially as the American national centennial would render it easier to gather together the chemists of the world for a celebration which could not fail. The present centennial meeting would thus serve to give strength to the affair. It would be none the less appropriate to dedicate to chemistry the centennial year of America's freedom; for did not Priestley strike the first blow to enfranchise the study of the material which constitutes one universe, and to give us correct ideas of it? So it was in 1776, that this nation struck the first blow for human freedom; an event for which men in England had struggled for five or six centuries, but had failed to accomplish, but which was effectually reached by the Declaration of Independence of 1776. In conclusion, Prof. Smith submitted the following resolution, which was carried unanimously:—

Resolved, That a committee be appointed to confer with the committee of the centennial exhibition, to correspond with chemists and professors of cognate sciences in Europe, in order to induce as large a representation as possible of them to visit our country in 1876.

In pursuance of this resolution the chairman appointed to act on this committee, Professors J. L. Smith, Gibbs, Hunt, Mallet, Joy, Leeds, Bolton, Horsford, Silliman, Barnard, and Barker.

A letter from Professor Rachel L. Bodley, whose suggestion, it may be stated, determined the location of this meeting at Northumberland, was read, in which she expressed her great regret at not being able to attend the exercises here, having previously made arrangements to make a botanical excursion near Denver, in Colorado.

Prof. Henry H. Croft, of University College, Toronto, then delivered an address on the Life and Labors of Dr. Joseph Priestley. See page 43.

Professor Horsford read extracts from some original letters written by Dr. Priestley to Judge Thatcher, who was at that time a member of Congress, and whose home was at Biddeford, Maine. Judge Thatcher was the only individual with whom Dr. Priestley ventured to correspond upon subjects of a political nature. The letters were loaned to Professor Horsford by Mr. Charles Deane, Secretary of the Massachusetts Historical Society. See page 47.

Professor Leeds called attention to some interesting references to Dr. Priestley, contained in the published memoirs of the Columbian Chemical Society for the year 1813, and especially to a very beautiful poetical tribute to Priestley contained in Darwin's "Botanic Garden." The extract referred to occurs in a paper on the effect of light on vegetables and upon the physiology of leaves, by Dr. Manners of Philadelphia, in which the discovery of the evolution of oxygen from leaves when exposed to sunlight is attributed to Dr. Priestley.

The morning session was then adjourned, all the chemists present being invited by the president to assemble in front of the mansion formerly occupied by the son of Dr. Priestley, and now the residence of the hospitable Mr. Joseph Bird. The day being clear and bright, a number of photographs were successfully taken by Mr. L. H. Laudy, representing the building in which the Loan Exhibition was placed, in the background, and the chemists who had been invited to deliver addresses, etc., in the front row.

The afternoon session opened with an address by Prof. T. Sterry Hunt, on "A Century's Progress in Theoretical Chemistry." See page 56.

Professor Persifor Frazer proposed the formation of a chemical society which should date its origin from this centennial celebration, and urged the importance of the fact that, while American chemists have done perhaps a larger amount of work in their own department proportionately than has been done in the world within the last century in any other branch of science, they have as yet in this country not a single society to represent the chemical thought of the country. The speaker moved that a committee of five be appointed by the president, to whom shall be referred the advisability of calling a representative committee of chemists of the United States to form a chemical society, and all questions relating to the organization of the society.

Prof. J. Lawrence Smith stated the difficulties which stand in the way of such an organization. One formidable objection was that this country was too large, and that it would be impossible to centralize its chemical research. Indeed, the very strength of the country is in decentralization. We want all our scientific institutions dispersed far and wide. We have already two great institutions in the country—the American Scientific Association and the American Academy of Sciences—which undertake to embrace in their proceedings everything connected with chemical research, and it would be more creditable to the chemical talent of this country if an attempt were made to secure its better representation in the chemical section of the former association. Even the meetings of the Chemical Society of London, where there exists a great centralization of chemists, are very meagrely attended, the members preferring to read their papers before the more distinguished Royal Society. The same is true of the French Chemical Society, while the attention of the Academy of Sciences of France is constantly asked to papers of the highest importance relating to chemistry.

The question was discussed at length by Profs. Wm. H. Chandler, F. W. Clarke, E. N. Horsford, E. T. Cox, B. Silliman, and Dr. Vander-Weyde, all of whom, with the exception of the first named, who presented forcibly many cogent arguments in favor of the formation of a national chemical society, advocated the earnest co-operation of the chemists as a body with the American Scientific Association, and that if a national chemical society were formed it should be as a permanent section of that body. At length Dr. Bolton, who, at the outset of the somewhat heated debate, had hoped that it would be possible to form a great chemical society on an enduring foundation of its own, perceived that the sense of the meeting was strongly against the advisability of such a new departure (at least at the present time, and before trying what could be done by vigorous action on the part of all the chemists in concert with the American Association), and offered the following amendment to the motion of Prof. Frazer:—

Resolved, That a committee of five be appointed from this meeting to co-operate with the American Association for the Advancement of Science at their next meeting, to the end of establishing a chemical section on a firmer basis.

The resolution was adopted, and a committee was appointed consisting of Dr. Bolton and Professors Silliman, Smith, Horsford, and Hunt.

The Committee on Telegrams submitted for the approval of the meeting the following telegram, which was ordered to be forwarded:—

Telegram to Birmingham.

Northumberland, Pa.,
July 31, 1874, 3 P. M.

"To the Priestley Memorial Committee, Birmingham, England:—

"Welcome despatch received. Professors J. Lawrence Smith, Youmans, and Joy, appointed committee to represent us in spirit at unveiling of Priestley's statue."

The afternoon session was then adjourned.

After tea the chemists, in company with a large number of visitors, were conducted to the cemetery to see the grave of Dr. Priestley, and to listen to the memorial address. The grave of Priestley lies in a pretty spot, the elevated position of which commands a view of the towns of Sunbury and Northumberland. A plain marble tombstone marks the spot where the philosopher reposes, and on it this brief and simple epitaph.

TO
THE MEMORY OF THE
REV'D DR. JOSEPH PRIESTLEY,
WHO DEPARTED THIS LIFE
ON THE 6TH OF FEBRUARY, 1804,
ANNO ÆTATIS LXXI.

Return unto thy rest, oh my soul, for the
Lord hath dealt bountifully with thee.
I will lay me down in the peace and sleep till
I awake in the morning of the resurrection.

Standing uncovered, the large audience listened to an oration by Henry Coppée, LL.D., President of Lehigh University, who at short notice had kindly undertaken to fill the place of Professor Henry, prevented by sickness from being present. See page 53.

On the conclusion of the address, in the beautiful twilight the people who were assembled quietly made their way down from the grave and hill to the lecture-room, to listen to the address by Prof. J. Lawrence Smith, of Louisville, Ky., "A Review of the Century's Progress in Industrial Chemistry." See page 61.

The Second Day's Proceedings: "Oxygen Day."

The morning session, August 1st, opened at 9 A. M., when Prof. J. L. Smith called the attention of the chemists and all others present to the claims of the Liebig Memorial Fund. He concluded his appeal with the following:—

Though chemistry has its hundredth anniversary appropriately celebrated on two continents on this day, this science has also a half-way point which claims in no small measure our appreciation. During the past one hundred years there have been not only many discoveries in chemistry, but there has been a vast development of chemists—the soul and spirit of the achievements which have already been rehearsed here. Something in the spirit in which we are in the habit of celebrating our silver and golden weddings, a movement has been commenced in Germany, which might be said to commemorate the silver epoch in the history of chemistry. That silver epoch dates back just about fifty years. It was the birth of Organic Chemistry. Although this

circumstance is due to many eminent scientists, yet one man more than all others gave it a brilliant conspicuousness and permanent development, and obtained those results which have been of the best service to us in our industrial and educational pursuits. Justus Liebig, lately deceased in Munich, it was who first made himself known to the world, just about fifty years ago, by his grand discoveries in organic chemistry. But it is not alone his wonderful achievements in this line that have made his name so dear to chemists and so familiar to the people of every land. He was pre-eminently the patron of the chemists of the past thirty or forty years, and the chemists of the present day, the agriculturists and the manufacturers, are more indebted to Liebig than to any other man who has lived since that date. His peculiar benefits to the world are recognized by all—there is hardly a child from California to Russia but knows who Justus Liebig was—but to chemists he was a great man. He first established a laboratory which was open to the world, and where all might receive instruction from himself. To his students he ever lent his encouragement and aid, and thus built up the chemists of the present day. He was a lovable man in every respect, and drew around him strong friendships. It is true he had his "notions." Some of them, as is natural of course, were erroneous, but to have made Liebig's errors would have made ten men great. He himself said at one time, "Show me a man that has made no error, and I will show you a man that has done nothing." He is dear to the chemists of America as well as of Europe, and it is proposed that we subscribe what we can each individually afford to a fund toward the monuments that are to be raised to Liebig at Munich and Giessen.

Prof. Silliman suggested, that, while chemists had not the art from their predecessors of transmuting the baser metals into gold, they could perhaps initiate a movement by which those who have profited by Liebig's work—and who has not?—might be induced to assist in these subscriptions.

Prof. Horsford said that it was the privilege of his life to have been a student under Liebig. Many of his sayings had sunk deep into his mind. His memory of what Prof. Smith quoted was a little different. Baron Liebig made the remark to Prof. Horsford, when the latter was deeply regretting some mistake that he had made. Liebig said, "The people who don't work make no mistakes." On another occasion Liebig said to him, while walking in a garden among a number of plant-pots, in which agricultural experiments were proceeding, "Make it a point to be useful to humanity." Some of his inventions have revolutionized agricultural chemistry. He was ever simplifying apparatus. He said to Brodie, a pupil, "When you start your new laboratory in London, begin with the anvil and make everything yourself; you will make mistakes, but will also make discoveries." The students of Liebig all are affiliated together with a sort of personal feeling—there is no school of chemistry—it is that they are attached by the memory of a noble life.

Subscriptions to the amount of about $650 were announced, with the understanding that they were to be devoted to the monument at Geissen only.

The applause which greeted the reading of this announcement was followed by the reading of an Essay by Prof. Benjamin Silliman, on "American Contributions to Chemistry." See page 70.

At the conclusion of Prof. Silliman's address, the following letter was read from President F. A. P. Barnard.

Columbia College, New York,
President's Room, July 29th, 1874.

Joseph Priestley, M.D.:—

Dear Sir: Having unfortunately been prevented by causes beyond my control from participating in the jubilee to be celebrated on Saturday next in commemoration of the most signal incident in the early history of modern chemistry, I cannot refrain from expressing, in the only form which remains open to me, my cordial sympathy with the impulse which has prompted this movement to do honor to the discoverer of oxygen.

Such, since the date of that ever memorable discovery, has been the progress of the world in every department of science, that we seem now almost to be living in a totally different planet.

Looking backwards upon the past, we find it scarcely possible to believe that so marvellous a history can be repeated. Yet, if we consider that for every Priestley of a century ago there are now at work hundreds at least as earnest and persevering, if not as gifted, and that of natures's countless mysteries we have as yet unveiled only the most obvious, we may easily believe, that when those who rise up to fill our places some generations hence, shall reverently assemble, as they doubtless will, to crown with honor the second centennial of this illustrious pioneer, we too shall seem to them as he seems to us now, to recede far back into the dawn of a day which we are idly flattering ourselves is already in the fulness of its mid-day brightness.

That such may be the case not only in the second, but in every succeeding centennial, will be the hope and wish of every true devotee of science, content himself to shrink into insignificance, so that the great cause of truth be advanced.

I am, very respectfully, your obedient servant,
F. A. P. Barnard.

A very interesting autograph letter of Dr. Priestley to Dr. Franklin, dated June 24, 1787, was then read by Prof. Pynchon, of Trinity College, Hartford, Conn., into whose possession the letter came by inheritance.* See page 52.

The Finance Committee reported a balance in their hands of $22.81. (This was subsequently increased to $40.81.)

Mr. Elwyn Waller moved "That the balance in the hands of the treasurer be expended for a suitable photographic album, and that all the gentlemen who had placed their names on the treasurer's list be requested to send their cartes-de-visite to Dr. H. Carrington Bolton, School of Mines, Columbia College, N. Y. Also their autographs, on a separate paper, to be inserted below their photographs. It is proposed to present this Memorial Album to Dr. Joseph Priestley and his family, to be preserved by them and their descendants until the meeting of the next Centennial of Chemistry in Northumberland, Pa., on the 1st of August, 1974." Adopted with great applause.

The chairman of the Committee on Resolutions, Prof. J. W. Mallet, presented the following report, which was adopted:—

Resolved, By the American chemists assembled at Northumberland to commemorate the discovery of oxygen gas by Joseph Priestley on the 1st of August, 1774, and his other great services to science,

That they have the greatest occasion to appreciate the remarkable kindness and hospitality which have been extended to them by the ladies and gentlemen of

* This letter has been reproduced by Mr. J. W. Osborne, by means of his photolithographic process, and he has very kindly presented copies of the beautiful fac-simile to many chemists.

Northumberland generally, under the wise arrangements of the Local Committee, who with great good judgment and efficiency have attended to every detail required to render the occasion the source of unalloyed enjoyment to their guests—and for this courteous and kind welcome they desire to return their most cordial thanks.

They have learned with much regret of the painful illness of the worthy secretary of the Local Committee, Dr. Robert B. McCay, which early deprived the committee of his valuable services, whose place has been kindly supplied by Mr. M. B. Priestley.

That they have experienced a lively satisfaction in meeting so many descendants of the illustrious man whose memory they have met to honor—a family whose present members have vied with each other in their efforts to render the visit of the American chemists to the philosophic retreat and peaceful grave of Joseph Priestley in all respects most agreeable and impressive.

That they appreciate the kindness of the amateur musical organization which has supplied such agreeable interludes to the more serious business of the sessions.

That they are also under obligations to the various railroad companies which have extended facilities to the visitors on this occasion.

That they regret the sudden indisposition of Prof. Joseph Henry, the Nestor of American science, should have deprived them of the pleasure of hearing his voice in memory of the life and character of Priestley, when assembled at his grave on the quiet and beautiful slopes overlooking the Susquehanna—an office which, however, in Prof. Henry's unexpected absence, was so admirably executed by Dr. Henry Coppée, President of Lehigh University.

And, finally, they desire to express their thanks to Dr. H. Carrington Bolton, to whose timely suggestion and considerate attention to needful details they are largely indebted for the opportunity they have enjoyed of participating in this memorial gathering, to which they will all look back with the greatest satisfaction—a satisfaction much enhanced by the sympathetic communications by the ocean cable with their fellow-workers in the common cause in the mother country.

On motion of Prof. J. L. Smith, it was now resolved that "The committee authorized to confer with the Committee of the Centennial Exhibition," etc., be authorized to increase its numbers.

The meeting then adjourned.

ALBERT R. LEEDS,
Secretary.

The Loan Exhibition.

A most extensive and interesting collection of apparatus, manuscripts, and pictures relating to Dr. Priestley, was exhibited during the meeting at the house of Mr. Joseph Bird.

Among the apparatus belonging to Dr. Priestley were retort stands, horse-shoe magnets, brass globes, astronomical apparatus, telescopes, microscopes, scales, earthen tubes, iron cylinders used for retorts, magic lanterns and many views painted on glass, compasses, small furnaces, a large Leyden jar, glass tube, bell jars, alembics, receivers, etc. etc.

There was an original autobiography in the handwriting of Dr. Priestley, engravings showing the destruction of Priestley's house and laboratory in Birmingham, and a fine oil painting of Dr. Priestley by Stewart.

A few pieces of apparatus belonging to John Dalton were loaned by Prof. H. H. Croft.

Some interesting alchemical works were exhibited by Dr. P. H. Vander-Weyde, and a series of eighty engraved portraits of alchemists and chemists was exhibited by Dr. H. Carrington Bolton.

Poem.

THE PRIESTLEY CENTENNIAL.

BY JAMES AIKEN.

[Read by the Author, at Dr. Joseph Priestley's House, on the evening of August 1st, 1872.]

Though not a scientific man,
Yet Science benefits me too;
For Science teaches those outside
Such pleasant, useful things to do!

Handmaid of Truth should Science be;
True Science such has ever been:
Warring against Humanity,
Was noble Science never seen.

The realms of matter to explore,
To ascertain its secret laws,
Through centuries hath Chemistry
Marched slowly on, without a pause.

One hundred years ago to-day,
In science was an epoch bright,
When Providence, through Priestley's toil,
Bestowed another gleam of light!

Honor to those whom God ordains
To bless the world with knowledge clear—
A Newton, Priestley, Franklin, Watt—
O, let us hold their memory dear.

We can't enumerate them all!
In every land and age have they
With honest zeal been toiling on,
To turn our darkness into day.

One name, one honored name we hail,
While standing near his burial ground—
The name of Priestley, synonym
With learning solid and profound!

Oh what an active brain had he,
And clear discriminating mind!
Through life his great desire was this:
To bless and elevate mankind.

A SKETCH OF THE LIFE AND LABORS OF JOSEPH PRIESTLEY,

BY PROFESSOR HENRY H. CROFT,
Of University College, Toronto, Canada.

Mr. Chairman, Ladies, and Gentlemen: It was with considerable reluctance that I took upon myself the duty of addressing you to-day on the subject of "Priestley, his Life and Labors," knowing full well that there were so many gentlemen, who are present, who could have performed the duty much more efficiently.

Considering, however, the very great honor conferred on me, an entire stranger, so kindly conceived and so courteously offered, I thought it would be ungracious in me to refuse.

Another reason which influenced me in accepting the position is, that biography can scarcely command or require any originality of thought or expression. Hence the duty became somewhat less onerous, for the life of Priestley is a matter of history. I come before you, then, by your kind permission, as a representative of Canadian chemists—few, I am sorry to say, but we are

only a young country. Perhaps I might claim to be a representative of a larger community—the Chemical Society of London—of which I might almost say I am one of the original members, having joined it some few months after its formation. On looking at the list of members, some three or four years ago, I found that there were only sixteen of the original members beside myself, and of these many have since left us.

The sketch of Priestley's life which I propose to read to you has been drawn up from various works, of which I will mention a few.

Dumas' "Leçons sur la Philosophie de Chemie," published in, I think, 1839; Kopps' "Geschichte der Chemie;" Thomson's "History of Chemistry;" "Lives of Celebrated Men;" Brougham's "Philosophers of the reign of George III;" Cuvier's "Éloge;" a critique on memoirs of Joseph Priestley, published in the *Edinburgh Review* of 1806, and written, as I learn from a pencil-note in our old copy, by Jeffrey, a critique just in many respects, but somewhat hard; various biographical sketches, such as I have been able to obtain access to. The original lives by, I think, his son, and by some other author [Corry], I have not been able to consult. His philosophical, or rather scientific papers, are contained in the Philosophical Transactions of the Royal Society. Of these I have numbered about forty; probably some are omitted.

Priestley's life may be said to have been twofold or manifold. He was an ardent investigator of scientific truths; he was also an "angry polemic," and a "fiery politician." So multitudinous are his works on these and many other subjects, so versatile seem his talents to have been, that, as Dumas remarks, we feel almost inclined to believe there must have been two or more Priestleys, just as some have imagined there must have been *two* bearing the name of Raymond Lullius.

Few writers have been more voluminous; but Brougham remarks—few are now less read.

I have no doubt there are many among my audience to whom much of his history is well known; but there may be some to whom it is unknown, and I will ask the indulgence of all while I describe, as briefly as I can, Priestley's life. In so doing, you must bear in mind that I am not his biographer, but simply a compiler or repeater of his biographies, and I shall confine myself to some very brief remarks on his early life, to a few of his religious and political discussions, leading to his unfortunate relations in England, and his consequent settlement in this country, and in the town in which we now meet; and then proceed to that which is of most interest to us, who now assemble here to day, the chemists of America, the consideration of his labors.

I will make my sketch as short as I can, for I consider we meet here to-day to celebrate not so much the discoverer as the discovery. None of us knew Priestley; we revere him, we honor him, for his discoveries less than for himself.

Born at Fieldhead near Leeds, in 1733, of very strict Calvinistic parents, Joseph Priestley, at a very early age, acquired strong religious tendencies; but although at first a Calvinist, he soon began to entertain ideas for himself, and got into a state of doubt, becoming somewhat of a convert to Arminianism. At this time we find him devoting himself to the study of not only the ancient languages, such as Latin and Greek, together with the modern ones, but also, in aid of his biblical researches, of Hebrew, Arabic, Chaldee, and Syriac. His power of acquiring languages, and his memory generally, seem to have been enormous, and rendered him in future years a most formidable antagonist in all those polemical discussions in which he was so prone to engage.

His religious opinions were what at that time was considered peculiar and heterodox; and, on attempting to enter the ministry, he was rejected on account of his views with regard to original sin, the atonement, and eternal damnation, views which, resulting from his own fervent convictions, he maintained openly and fearlessly, and subsequently, although acting as preacher at Needham, he failed to become popular, partly on account of an impediment in his speech, but more from his known tendency to Arianism and to Socinianism. To the latter sect, better known under the name of Unitarians, he finally belonged. Brougham sarcastically remarks that the people of Needham probably thought their privilege of eternal hell-torments to be rudely invaded by their preacher.

His disbelief also in the Trinity being notorious, he very soon—at the early age of twenty-five—got into disagreeable relations with many parties, and had to leave Needham. At Nantwich he succeeded better, established a school, and commenced his scientific studies, for which, however, he had had very little preliminary preparation. These he continued afterwards at Warrington, whither he removed in 1761.

An acquaintance with Benjamin Franklin led him to turn his attention to electricity, and within the year he produced his "History of Electricity," a work which, although thought much of at the time as a useful compilation, does not seem to have added greatly to his reputation; the same may be said, to a greater extent, with regard to his "History of Vision," both works being too rapidly and carelessly written, a common fault with all Priestley's writings. He made a number of experiments on electricity, which, although not adding much to the science, rendered his name so well known, that he was elected member of the Royal Society. According to another biographer, he had been a member a year before. It was much easier to become an F.R.S. then than now; but we must remember that Priestley's most brilliant discoveries, which gained him the gold medal and recognition from crowned heads, came afterwards.

About this time there was a chance of his being appointed chaplain on Captain Cook's second voyage, but here his unfortunate religious opinions came in his way, and he was rejected by the admiralty on account of his heterodoxy, which, however, it has been remarked by one of his biographers, did not seem likely to have in-

terfered materially with his observation of stars, plants, and natural phenomena generally.

While at Warrington, 1761–1769, his pen was most prolific, and among his writings may be mentioned, "A Theory of Languages," books on "Oratory and Criticism," on "History and General Policy," on the "Constitution and Laws of England," on "Education," a "Chart of Biography," a "Chart of History."

In 1767 he removed to Leeds, and became minister of the Mill-hill Chapel, and wrote many controversial books and pamphlets. In after times he wrote "Letters to a Philosophical Institution," "An Answer to Gibbon," "Disquisitions on Matter and Spirit," "Corruptions of Christianity," "Early Opinions on Christ," "Familiar Letters to the Inhabitants of Birmingham," "Two Different Histories of the Christian Church," "On Education," "Comparison of Heathen and Christian Philosophy," "Doctrine of Necessity," "On the Roman Catholic Claims," "On the French Revolution," "On the American War," besides twenty volumes of tracts in favor of Dissenters and their rights. (Brougham.)

In 1773 he entered the service of Lord Shelburne, afterwards Marquis of Lansdowne, as chaplain, and remained with him for seven years, leaving with a pension of £150 per annum, and no ill feeling on either side, but probably from the openness with which he expressed, and the pertinacity with which he maintained, his own opinions on religious, political, and indeed all other matters. In Lord Shelburne's company he visited Paris, and various parts of the Continent, and at Paris was present at a discussion between two chemists as to the nature of red precipitate, what we now call mercuric oxide. It is not improbable that what he heard that day led to his future experiments, and hence to this meeting.

Leaving Lord Shelburne, in 1780, he settled in Birmingham, and continued his scientific and theological studies and writings for several years. Unfortunately he entered into a violent controversy with members of the Established Church, and, as he had no hesitation in expressing his views very freely, and did not confine himself to polemical discussion with the above named sect, but equally Calvinists and Arminians, Arians, Presbyterians, Methodists, Roman Catholics, and Swedenborgians, it is not to be wondered at that he got into some disrepute. It was not sufficient for any one to agree with him partly, he must agree entirely; a deviation of a thousandth of an inch either one way or the other constituted an antagonism. Indeed, it is doubtful whether any one ever entertained Dr. Priestley's belief except Dr. Priestley himself. (Brougham.)

Whatever amount of toleration in religious matters there may be in England now, there was much less a century ago. The Established Church looked upon all Dissenters with suspicion and dislike; and the government of the day, fearing the introduction of reform and liberal opinions, emanating generally from the dissenting portion of the community, took much the same view.

So powerful a writer on religion and politics was an eyesore to a Tory government. Burke's paper on the French Revolution had been answered by Priestley in such a manner as to arouse the indignation of that statesman, and to cause him to attack Priestley with great virulence, even in the House of Commons.

The French Revolution itself had also much to do with the ill feeling which arose in England against Priestley. His open expression of admiration for the new republic, conjoined with his very free writing on religious subjects, led many Frenchmen to believe, very erroneously, that he entertained similar views to those held by themselves. When in Paris, he was told by certain savans that he was the only sensible man they had ever met who believed in Christianity. Hence, while laughed at in France for being a Christian, he was decried in his own country as being what some persons called an atheist.

The latter is entirely untrue, for there was probably never a more truly moral and religious man than Joseph Priestley. Thomson says: "He admitted the whole of the sublime morality and the divine origin of the Christian religion, which may charitably be deemed sufficient to constitute a true Christian."

To this remark I confess I most cordially concur; but ideas in England, in 1780, were not so liberal. Priestley had rendered himself obnoxious to the Church by his so-called heterodox ideas on religious matters; to the government by his bold advocacy of liberal opinions; to the people of England generally by his openly expressed admiration of the French Republic. The popular feeling was at that time very strong against France; and the fact of a minister of religion expressing his admiration of a system which only three weeks before had been instrumental in causing those atrocious butcheries which disgraced the French Republic, naturally created a feeling against Priestley, for which, however, he was not in the least accountable, any more than the British nation was guilty of the unwarrantable treatment to which he was shortly submitted at the hands of a mob and some prejudiced parties.

On a celebration of the storming of the Bastile, held in Birmingham, at which, however, Priestley was not present, popular feeling rose to such a height that the church and house of Priestley, and those of many of his friends, were destroyed by the mob. We know what an unreasoning thing a mob is. You in the United States are not entirely unacquainted with it. On a recent visit to England I went to Nottingham and saw the castle, one of the most magnificent edifices of England, in ruins, from some absurd popular outbreak, I believe of the Chartists.

I have seen the Parliament Buildings and excellent Library of Canada burnt down by a mob, because a bill had been passed which did not meet the views of a minority.

Priestley, not sure of his life in Birmingham, went to

London, and here he found the feeling still strongly against him, a feeling for which I shall not attempt to apologize, as it is something which at this time we can scarcely conceive.

He had the greatest difficulty in obtaining a lodging, the landlord being afraid of his house being burnt down. He was shunned by the members of the Royal Society. His life was embittered, and he left England for a land where he was sure his religious and political opinions might be freely promulgated, without interference and without complaint. He was somewhat wrong; the same odium, which attached to him in the old country, accompanied him here to a slighter extent. Clergymen of any other sect looked on him as a heathen, though, when they came to know him, they acknowledged their transgressions. I have no time to introduce illustrations of this, which I might do. His political principles found no favor with the Adams administration, and I am told he was threatened with expulsion from the country. Under Jefferson's reign Priestley was at peace, and ended his days, after a continued writing on religious and scientific subjects, here, where we are assembled to-day.

I believe he was failing for two years before his death, and place no credence on the story told by Dumas, that he was accidentally poisoned by some article eaten by the whole of his family, but which had a fatal effect only on him. I find no notice of this in any other writer.

It is scarcely in my province to speak of Joseph Priestley's character as a moral man; but in all that I have read, I find him described as a strictly honest, upright, moral, and religious man, with faults—who has them not? Although a most furious polemic, those who were opposed to him, when personally acquainted, became his friends; his religious opinions, opposed as they were to those of many with whom he was thrown in contact, often produced ill-feeling which gave way to his own personal amenities.

Let us now turn from Priestley's life to Priestley's labors. Here we find the theological, political, and literary, entirely overpower the chemical, occupying, I believe, about fifty or sixty volumes. With these we need not occupy ourselves (I have given a few instances already), but confine our attention to his labors on that science which is specially represented here to-day.

The discoveries which Priestley made in chemistry would have established the fame of half a dozen ordinary workers, and yet it cannot be said that he possessed any very profound knowledge of the science as it then existed; indeed, in many parts he was very deficient.

He himself modestly ascribes most of his discoveries to accident, herein perhaps not doing himself the justice he deserved; accident has doubtless much to do with chemical discoveries, more perhaps in former times than now, when researches are usually undertaken with some definite end in view; but how many of the discoveries which have led to the most brilliant and important results, may not be called accidental? I question if Davy expected to find potassium when acting on potassa with a voltaic battery, although, having already observed the decomposition of other metallic oxides, he may have had an inkling of the fact. Bunsen did not expect to find two new metals when examining the residue from the Durckheim waters. Crookes, when looking for selenium, accidentally found thallium. Perkins, when he found that aniline, when acted on by chromic acid, gave a fine color, could scarcely have expected the enormous manufacture of these or analogous dyes, which is carried on at the present day.

However much Priestley may have been assisted by accident, we are none the less indebted to him for them, and for the consequent enormous impetus given to our science.

The first chemical investigations of importance made by Priestley seem to have been at Warrington, where, residing in the neighborhood of a brewery, he had ample opportunities of experimenting on *carbon dioxide*, *carbonic acid*, or *fixed air*, as it was then called. This gas was already known, and Black, while experimenting on it, had, to a certain extent, laid the foundation of pneumatic chemistry; but Priestley carried the matter out so much further and with such ingenuity as to entitle him to be called, as he has been, the father of that branch of the science.

His apparatus was all made by himself, or by unskilled workmen under his direction, and much of it we use at the present day in our lecture-rooms. He first introduced mercury for collecting gases soluble in and therefore not to be collected over water; and it seems probable that he obtained chlorine, but failed to recognize it, perhaps from its action on mercury.

The fact of carbon dioxide being soluble in water, and also to a greater extent under increased pressure, was known to Priestley; hence our so-called soda water manufactory.

Hales had made some experiments on the production of nitric oxide, but Priestley carefully examined and described its properties. He found in it a reliable means of detecting the presence of vital air, "dephlogisticated air," or oxygen, as we now call it. He was in the habit of using small animals, such as mice, for proving the presence or absence of the vital air, and found in the nitric oxide a chemical test not requiring the sacrifice of animal life. In one of his experiments, he left the mouse for some months in the jar, and on examining it, found the carcass perfectly fresh and sound. This fact seems to have been overlooked. The preservation of meat by means of nitric oxide has been recently introduced, one hundred years after Priestley's observation.

Another discovery of his was that of nitrous oxide, produced I believe by the action of iron on nitric oxide; the properties of this gas were examined, but I am not aware that he was acquainted with its physiological effect; that was left for Davy. And here I may mention a fact that I learnt only a few days since, viz., that Davy proposed or hinted at the possibility of employing nitrous oxide in surgical operations. (See Silliman's address in 1871.)

In the course of his investigations upon gases, he found that, however different in density, they commingle and remain so for any length of time, a subject further investigated by Dalton. He also found that gases would mix when separated by bladder, which may be said to have been the foundation of osmose and of the brilliant discoveries of Graham and others. This observation was made in Northumberland, but seems to have been overlooked.

The reduction of metallic oxides by combustible air or hydrogen was known to him, although, on account of his adherence to the phlogistic theory, his explanation was not correct. I may add that the last scientific paper he wrote in 1802 was in defence of this theory. He found that vital air or oxygen turned dark venous blood red, and that plants inhale oxygen in sunlight. In Northumberland he also discovered carbonic oxide, but for the same reason as mentioned above did not understand its nature.

Fluoride of silicon, sulphurous acid, hydrochloric acid, were all discovered by Joseph Priestley. Ammonia was another of his discoveries, and he found that when treated with electric discharges it increased its bulk, but he failed to show its composition. It has been said that he was the first to employ electricity in this way, but it seems that Volta had done so before him. He also seems to have been the first to notice the formation of water when electric sparks are passed through a mixture of air and hydrogen, a fact afterwards examined by Cavendish, and on which an hypothesis was founded by Watt.

I know there are many discoveries of his which I have omitted, but they were not of the striking character of those I have mentioned, and enough has been said to show how successful he was as an experimenter. Of the most important gases known at present, we owe nearly three-fourths to Priestley. I shall not dilate on the importance of his principal discovery, viz., that of oxygen, that more properly belongs to the address which you will hear from Prof. Hunt.

In conclusion, let me draw your attention to the articles shown in the loan exhibition, which are specially interesting to us as having been perhaps some by which his discoveries were made; to supplement them to a certain extent, I have brought with me a few articles which were used by Dalton, a man as famous as he whom the chemists of America have met here to-day to honor.

PRIESTLEY'S LETTERS.

PRESENTED BY E. N. HORSFORD.

At the conclusion of Prof. Croft's address, the president invited the presentation of personal reminiscences of Dr. Priestley. Prof. Horsford stated that there had been placed in his hands by Charles Deane, Secretary of the Massachusetts Historical Society, to be read if occasion should call for them, a series of letters written by Dr. Priestley between 1788 and 1800 inclusive, to Hon. George Thacher, member of Congress from the district of Maine. The accompanying note* from Mr. Deane, who kindly acquiesced of the wish of the officers of the Centennial Congress, that the letters might be published as a part of the proceedings of the celebration, will sufficiently indicate the character of the gentleman who enjoyed the confidence of Dr. Priestley at this period of his life.

The letters, with here and there an omission, which the limited time seemed to make necessary, were read. They are now presented complete, *verbatim et literatim*, and will be found to shed most grateful light upon the character and life of the great and good man.

NORTHUMBERLAND, Dec. 28, 1798.

DEAR SIR:—

I am glad to find that you are returned to Philadelphia, and that you are not afraid to correspond with so dangerous a politician as I am; and as I have no correspondence with any other member of Congress, I shall perhaps be troublesome to you.

I have employed myself this summer very much in my laboratory, and have sent several articles of a chemical nature to the *Medical Repository*, printed at New York. Four of these, I hear, will be published in their two next numbers, and I have one more to send. The object of them all is to show the fallacy (as it appears to me) of the French theory. But I want to hear from the French chemists themselves, and when we shall have any intercourse with that abominable country you Federalists can tell better than I can. I suffer much in various ways for want of it. Who are the gainers I cannot tell.

I shall very soon print my *Comparison of the Institutions of Moses with those of the Hindoos*, etc., in this place, at my own expense, and shall be obliged to my friends if they will take as many copies as they can dispose of, that my loss may be the less. But I shall not again propose to print any Works by *subscription* in this country.

My son, who expects to be in Philadelphia in about a Week, will endeavour to make some agreement with Mr. Gales about the printing of my *Church History*, if he will take *lucre* which I have, instead of *mines* which I have not. If this can be done, I shall be much obliged to you for transmitting the proofs, etc. But

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* CAMBRIDGE, MASS., 10 August, 1874.

MY DEAR MR. HORSFORD:—

I am glad to learn from you that the letters of Dr. Priestley which I intrusted to your care to be exhibited at the recent Centennial Celebration at Northumberland excited considerable interest; and you add that a wish has been expressed that copies may be taken for publication. In complying with this request, I desire to say a single word concerning the distinguished gentleman to whom the letters were addressed – the Hon. George Thacher. He was at this period a member of Congress from the District of Maine. He resided at Biddeford. He had been a delegate to the Old Congress, and a Judge of the District Court of the United States. In 1801, having accepted the appointment of Judge of the Supreme Judicial Court of Massachusetts, which position he held till 1824, he resigned his seat in Congress. He died on the 6th of April in the year last named. Judge Thacher was a man of the highest character for probity and intelligence. He was a great reader, was particularly versed in polemical and theological controversy, and was celebrated for his wit. He was a stanch Federalist in politics, but was attracted to Dr. Priestley by his advanced religious opinions and by his metaphysical writings, and no doubt by admiration of his character. It is said also that Judge Thacher's scientific attainments were respectable.

These letters were intrusted to me some years ago, with the understanding that I should ultimately place them in some public depository. Before doing this I had designed to suitably annotate them and print them, having myself always had a great admiration of Dr. Priestley; but I have never found time to do this, and I am now happy to submit them to you for publication in the manner you have suggested. I will then make such disposition of the originals as was intended.

Faithfully your friend,

CHARLES DEANE.

what can I do when you are not in Philadelphia, as the expense of postage will be very great?

When I wrote last, I think I had finished my Exposition of *Daniel* and the *Minor Prophets.* I have since that completed, and transmitted my Exposition of *Isaiah, Jeremiah,* and *Ezekiel,* and reverting to Genesis, have about half finished the Pentateuch. In the course of the next summer I hope to finish the whole. This will be a large work, and whether it will ever be published is very uncertain. But if not, I cannot employ my leisure hour more to my satisfaction; except, you may say, in disturbing peaceable kingdoms and States. But of my political publications I must not say anything to *you.*

Yours sincerely,
J. Priestley.

P. S.—I wish you would send me the American edition, I see advertised in Brown's Newspaper, of the *Intercepted Letters* addressed to me; and any political intelligence you dare to trust me with.

Northumberland, Jan. 7, 1799.

Dear Sir:—

As you do not complain of the liberty I have taken, I shall trouble you pretty often in the same way. As my son has probably sailed before this time, I wish you would tell Mr. Gales that he agreed with Mr. Kennedy, the printer in this town, about the printing of my "Comparison of the Institutions of Moses," etc., and undertook to buy a quantity of type for the work, and that I have seen the paper maker; so that if, as he writes to Mr. Degrachy, he has made any agreement with Mr. Gales about the printing of the same work, he must have forgot what was done here, and that I think myself bound by. If he has agreed with him about the printing of the Church History, it is very well, and part of the copy shall be sent to Mr. Gales whenever he chooses.

You say you wish I were as zealous a friend of America as Mr. Hone is of France. Both Mr. Hone and myself, as well as Dr. Price and many others, were as zealous in the cause of America as he now is in that of France. If I had not been so, I should not have come hither, nor am I changed at all. I like the country and the Constitution of your Government as much as ever. The change, dear sir, is in you. It is clear to me that you have violated your Constitution in several essential articles, and act upon maxims by which you may defeat the whole object of it. Mr. Adams openly disapproves the most fundamental article of it, viz., the election of the Executive. But as you say, we cannot see our own prejudices, and cherish them as truths.

I may be doing wrong in writing so freely, and I have been desired to be cautious with respect to what I write to you. But I am not used to secresy and caution, and I cannot adopt a new system of conduct now. There is no person in this country to whom I write on the subject of politics besides yourself, nor do I recollect what I have written; but I do not care who sees what I write or knows what I think on any subject. You may if you please show all my letters to Mr. Adams himself. I like his address on the opening of the Congress, and I much approve of his conduct in several respects. I like him better than your late President. He is more undisguised. We easily know what he thinks and what he would do, but I think his answers to several of the addresses are mere intemperate railing unworthy of a statesman.

My general maxims of policy are, I believe, peculiar to myself. When I mentioned them to Mr. Adams he was pleased to say that "if any nation could govern itself by them it would command the world." Of this I am fully persauded; but he has departed very far from them. All that I can expect is the fate of the poet Lee, who, when he was confined in a mad-house, and was asked by some stranger why he was sent thither, replied, "I said the world was mad and the world said I was mad, and they outvoted me." My plan would prevent all war and almost all taxes. But if the calamities of war, heavy taxation, the pestilence, etc., or any other evil, be required for the discipline of nations, as I believe that in the present state of things they are, they will be introduced from some cause or other. This country as well as others wants a scourge, and you are preparing one for yourselves.

With every good wish to you and your country, I am, dear sir (though an alien),

Yours sincerely,
J. Priestley.

Northumberland, Jan. 10, 1799.

Dear Sir:—

I sent you by Mr. Ecroya, *Mr. Belcham's answer to Mr. Wilberforce,* and by Mr. Humphreys, *Mr. Hone's pamphlet.* They may both be had by inquiring of Mr. Vaughan.

I hope I do not take too great a liberty in inclosing *two open letters,* for your conveyance according to their directions. I know they must not be *sealed.* I wish to write in the same manner to a friend or two at a great distance, and whom I wish not to burden with the expense of postage, but I shall not proceed any further without your permission.

I am, Dear Sir,
Yours sincerely,
J. Priestley.

P. S.—My daughter may bring back the pamphlets, but you may keep them as long as you please.

Dear [Sir]:—

I fear I take too great liberties with you: but I wish to convey the inclosed to my son, and hope you will excuse it.

I am sending to the press my *Comparison of the Institutions of Moses with those of the Hindoos,* etc.; but shall not be able to print my *Church History* at present. Had not Mr. Vaughan been so unfortunate, I could have done pretty well. But though I have landed security for the money I had in his hands, which is all that I have in this country, these lands are uncultivated, cannot be sold for anything at present, and yield no revenue. I go on, however, to write in hope of better times, but I shall no more propose a *subscription* to anything.

I send by this post an article for the Medical Repository, at New York, and once thought of troubling you with it; but on second thoughts have not. I have desired, however, Dr. Mitchell, my correspondent there, to send me some printed copies of what they print of mine to you to be conveyed under your cover.

I am, Dear Sir,
Yours sincerely,
J. Priestley.
Northumberland, Jan. 17, 1799.

P. S.—Say nothing to anybody, of what I wrote about Mr. V. &c.

Northumberland, Feb. 14, 1799.

Dear Sir:—

If I had not had the most perfect confidence in your friendship I should not have written to you as I have done on the subject of *Politicks*, knowing how very different your sentiments in that respect are from mine. I have no other correspondent to whom I mention the subject at all, and seldom think of it but at the moment of writing. My thoughts you may easily perceive are engaged other ways.

I am glad that you like Mr. Belsham's pamphlet so well. You may keep it, as I can get another easily. I should have added the article you wish for to the *History* of *Corruptions*, but I had little or nothing to say *historically* on the subject. I shall, however, attend to it, and endeavor to make a section to your mind.

I am quite ready to begin the printing of my *Comparison*, but fear we shall be delayed by the want of *type*. If you can do anything to forward it, I shall be much obliged to you. Be assured I shall never lose sight of the *exposition and corrected version of all the books of Scripture*, and the kind of illustration that you mention will be very particularly attented to. Hitherto I have united nothing of the kind that has come to my knowledge.

I have just received a letter from Mr. Lindsay, who mentions some *philosophical articles* that have been sent to me in *the Neptune*, Capt. *Joseph Saunders*. From the manner in which he speaks of this package, I conclude that I ought to have received it some time ago, whereas I have heard nothing of it, or of any advice concerning it, to Mr. Vaughan or myself. I shall be much obliged to you, indeed, if you will be so good as to make the necessary inquiry concerning it, and if it can be found, see it lodged safe till I can send for it. Mr. Lindsay also mentions a *parcell* of *books* that he has sent me; but he does not say by what ship, and another *smaller parcell* that was sent with this letter, but does not mention the ship. This, however, must be one that arrived very lately.

I suffer much by these delays and loss of parcells. If they lie at any public office, I fear they will be opened, and then it will be impossible for anybody to replace the articles without certain injury. Hitherto by Mr. Vaughan's interest I have been favored, the packages being sent hither, and I then informing them of the contents. I hope by your means to have the same favor continued. It is, indeed, of great consequence to me. All my books and instruments must come from England, which alone is a great disadvantage that I must labour under [in] this country independently of other circumstances. Mr. J. Vaughan is at No. 63 Duke Street, but perhaps does not make his appearance.

I shall print my *Comparison* at all events, and be thankful for any assistance my friends can give me by way of lessening the certain expenses attending it. Whether I shall be able to print anything more in this country is uncertain. I shall certainly go to the utmost extent of my own funds. My *Philosophical articles* will be printed in the *Medical Repository*, and cost me nothing. I am very busy in that way, but this does not interest you. I often wish this place lay in the way from Biddeford. It would give me great pleasure to show you my conveniences, which are beyond everything I ever had before. Yours,

J. Priestley.

Dear Sir:—

Looking into my *Institutes*, I find I have said all that I know, and I believe all that is known about the *devil*, etc., in the way of *argument*. I should now only say that I believe, with Mr. Palmer (now in Botany Bay), that the *fallen angels* of Peter and Jude were the *descendants of Seth*, who perished in the deluge. See the *Theological Repository*, vol. 5, p. 166. As to an *historical* article, I could not find material for one. I often wish you were nearer to me, that I might get your perusal of what I am composing for the press. Here I am absolutely isolated. When the Congress shall remove to the federal city, perhaps you may sometimes include this place in your way, and spend a week or more with me. Otherwise I shall hardly see you any more. [word wanting] your affection for England, I wish you would learn their exactness in the conduct of the *post-office*. The last post brought us newspapers, but the *letter bag* was left behind. I expected a letter from Mr. Russel and perhaps from you.

I wish you could get me the full *titles* and *dates* of the impression of Dr. [name cannot be made out] 's *History* of *Indostan*, and *Holwell's Interesting Historical* Events. I had them from the Circulating Library in Philadelphia, and returned them without noticing those circumstances, and I wish to describe them more circumstantially in my preface, than I have done in my reference to them. I am,

Dear Sir,
Yours sincerely,
J. Priestley.

Northumberland, March 1, 1799.

Northumberland, Dec. 12, 1799.

Dear Sir:—

Your letter was peculiarly welcome, for in truth, I was afraid you would have revolted at my *politics;* as you are so violent a federalist, and I such a democrat. Since, however, you could bear the *first* part of my letters, I will venture to send you the *second* by this post, and then you will know the worst of me.

The Porcupine's abuse had no effect on you, it had on many others; and even in this part of the country I was generally regarded as a dangerous person. For in this country it is not one person in a hundred that know any thing of my writings or my history. I was frequently called an *atheist*. Porcupine's paper was taken by all the most reputable federalists in these parts, and many I believe propagated suspicions of me that they did not entertain themselves.

Before I received your letter I had sent Mr. Dobson a copy of my *Comparison*, with directions that after he had looked into it (in order to judge whether it would be worth his while to take the impression upon himself or not), to deliver it to *you*, and I beg your acceptance of it. I have since heard that he declines having anything to do with it, except selling it on my account. This I wish to avoid, and another bookseller seems inclined to take it. I desire nothing for my trouble, but I wish to be *indemnified*, and to have as little as possible to do with the *sale*, as it is a thing that I should manage very ill. I should have preferred Mr. Dobson to any other bookseller, and I wish you would ask him to show you the letters I wrote to him on the subject. But do not solicit him to take it as a *favor* done to me. I do not like such obligations, and a bookseller I well know may get money when the author would be a great loser by the sale.

Mr. *Cooper's pamphlet* was sent, together with the copies of mine, to Mr. Campbell, bookseller, in Market street, by a wagon which left this town yesterday, so that you may soon see them.

I have now completed my *Notes on all the books of Scripture*, without omitting even *Solomon's Song*, which at first I did not intend to meddle with, as there is nothing of religion in it. My *Church History* was finished long before; but these I believe must remain to be disposed of by my executor.

I have completed my experiments in defence of the doctrine of *phlogiston;* and having now heard all that has been, and I believe *can* be advanced against it, I begin the next week to print my *Defensive Treatise* on the subject; and I pretend to nothing less than a *demonstration* of the fallacy of the opposite new theory, though supported by almost [all] the chemists in Europe, and this country too.

If you dare trust me with any political information, I shall be glad to receive it.

Yours, sincerely,

J. Priestley.

Northumberland, Jan'y 9, 1800.

Dear Sir:—

Having heard nothing from Mr. Dobson, and he having twice refused to have anything to do with my *Comparison*, I authorized a friend to dispose of it to Mr. Campbell, with whom the copies now are. He reimburses me all my expenses about it; but without the exertions of my friends, I fear he will be a loser by it, not indeed finally (for if any theological work of mine be readable, I think this will), but in these times it will go off very heavily, and he may be discouraged. I shall therefore be much obliged to you and to my friends in general, if you will recommend it where you have opportunity, and I hope that Mr. Dobson will promote the sales as much as he can, tho' he did not chuse to take the expense of it upon himself.

Mr. Campbell takes my *Letters* as well as the Comparison. With respect to *this* I only ask your forbearance, and if you think I have offended, your forgiveness. Consider, however, how long I bore every species of abuse without any reply. What I suffered with respect to *character* in this neighborhood you cannot know. But in consequence of perpetual and uncontradicted accusation, I was generally considered as a dangerous person. In this respect I find that these Letters have been of great use, and I have reason to think that, in consequence of the candid account of my principles and conduct, I shall have no occasion to trouble the public with anything farther on the subject, tho' I find there are many Porcupines in this country, and with them my case is not at all mended.

I have lately received some valuable theological publications from England, which I wish you could see; but I have no opportunity of sending them, and several of them are now bound up with other pamphlets. They do not, however, contain any sentiments that would be *new* to you. But they are well written, and excellently adapted to *existing circumstances*, as the phrase now is.

I often wish I could see you in my *shed* as it is called. But it is too much out of your way in going or returning from Congress; and besides we have not yet any stage coach to this place.

With every good wish, I am,

Dear sir, yours sincerely,

J. Priestley.

Dear Sir:—

I truly admire the candor you express with regard to my *Letters*. It is more than I expected even from you, and I must say that with the Federalists in general, it is very uncommon. At least so I have found it in my own case. I am pretty well known to have been (at some risk to myself) a zealous friend to your revolution when I was in England. When here I never meddled with your politics for five years, and yet no person in the country has been exposed to such outrageous abuse. As to the Federalists at a distance, I stand as I expected, just as I did before. The virulence of Porcupine is taken up by other writers, but I have mended myself a little here, and with that I am satisfied; and I hope I shall have no occasion to give you, or them, any further trouble in this way. It was with great reluctance that I did what I have done.

I shall thank you if you will tell me what you wished me to have omitted in the Letters, or anything in which you think I am *palpably* wrong. I do not mean to draw you into any controversy, but I will *think* of it.

Mr. Dobson has not acted like a friend with respect to the *Comparison*, and of my *Letters* which I did not mention to him, he says "*my friends are ashamed for me.*" I wish he would shew you my last letter to him that you may judge whether he had any occasion to write to me in that manner. I made him the offer of the Comparison three different times, desiring nothing but indemnification.

The *Layman's Answer to Wilberforce* is one of the pamphlets I wished to put into your hands.

I thank you for your good wishes with respect to my *Notes on the Scriptures*. They are ready, but when they will be *called for* does not depend upon *me*. I have just printed, except the Preface, a philosophical work, which I entitle *The doctrine of phlogiston established and that of the composition of water refuted.*

You will wonder at my confidence when almost all the world is against me. But I have cautiously examined the ground, and think I stand very firm. I do not think the allied powers have now the same confidence in their contest with France.

I trouble you with the enclosed for Mr. Campbell, and am

Dear Sir, yours sincerely,

J. Priestley.

Northumberland, Jan. 23, 1800.

Northumbeerland, Feb. 20, 1800.

Dear Sir:—

I trouble you with *two letters*, which I shall be much obliged to you to forward according to the directions. That to Mr. Baynham is somewhere *near Lake Champlain*, but probably you will be able to direct it better than I can.

I lately sent to Mr. Smith by Mr. Campbell, some copies of a *chemical tract* in defence of the doctrine of phlogiston. Tho' you are not a chemist, you may perhaps find something to amuse, and I hope please, you in the Preface, &c.

I am now writing a *Dissertation on the knowledge of a future state among the ancient Hebrews.* I have been used to think there were no traces of it in the Old Testament, but I now think they furnish me a demonstration of it. I wish I could submit it to your inspection. I shall transcribe it in a few days, and, if I have a good opportunity, will send it to you.

I shall be much obliged to you, and Mr. Vaughan, to

take two copies of my *Comparison* of Mr. Campbell and take the first opportunity of sending them as presents from me to Mr. Freeman of Boston, and Mr. Bentley of Salem.

With every good wish, I am,
Dear Sir, yours sincerely,
J. Priestley.

P. S.—I thank you for the enclosure by the last post.

North'd, March 6, 1800.

Dear Sir:—

I thank you for the *Magazine* you sent me. It contains many valuable articles. I am also much obliged to you for *Mr. Webster's Letters.* I have no thoughts at present of writing anything more in that way, but I may be led to think and act otherwise.

I am sending my *Dissertation on the knowledge of a future state among the Antient Hebrews* to England. Mr. Lindsey will probably get it printed in some form or other.

I am engaged in a promising train of *experiments*, and everything in this way is much more expensive here than in England. But I cannot be idle. You see that rather than do nothing, I even write on politicks, of which you Federalist, will say I know nothing at all.

With every good wish I am,
Dear Sir,
[Signature cut out.]

P. S.—I take the liberty to trouble you with the inclosed.

Northumberland, March 20, 1800.

Dear Sir:—

I thank you for the *Tract on Prophecy.* Everything on that subject interests me much. I wish I could see the *other tract* that Mr. Winthrop mentions. Perhaps you can send it me from Boston.

I enclose a letter for *Noah Webster* and wish you would complete the direction, and I do not know where he lives. I wish also, you would read the letter, and if you think there is anything in it, that you would not have me to say to him, suppress it.

I wish you would read the *Dedication* and *Preface* to my late *tract on phlogiston.* If I had thought the subject interesting to you, I should have sent you a copy. I am busy about some important experiments. Were you here I would not despair of exciting your attention to other things besides *theology* or *metaphysics*, tho' these are certainly of the first consequence, and I give most of my time to them.

I am, dear sir,
[Signature cut out.]

P. S.—Cannot you make this place on your way to the federal city, where I suppose Congress will meet the next year?

Dear Sir:—

I was much amused with the account of your being *taken in* by my treatise on *phlogiston.* In the future mind the old adage *Fronti nulla fides.* However, if you get *anything* for your half dollar it was not wholly thrown away, and you will be wiser another time.

I have lately been reading *Robinson's History of Baptism*, and it has led me to put down some thoughts on the subject, which I shall probably reduce into the form of a *tract*, and send to England after the Essay mentioned in my last. But I want to examine one of Mr. Robinson's references to the Works of St. Austin. My set is not compleat, one volume having been destroyed in the riots; and unfortunately the treatise referred to is in that volume. But *Austin's Works* I see are in the *Loganian library*, No. 84, Folio, in 8 volumes. I shall therefore be much obliged to you if you will consult it for me. Mr. Robinson says, p. 218, "Had he" (Austin) "forgot himself when he taxed the Pelagians with denying infant baptism;" and in the margin refers to the treatise. *De Peccaborum meritis, Lib. 2, Cap.* 25 (or Penatorum.—E. N. H.). This is the tract that my set is deficient in. He has another reference to a treatise which I have; but it contains nothing to his purpose, and therefore I strongly suspect that the other does not. In other places Austin takes it for granted that the Pelagians, as well as all other christians, allowed of infant baptism; and from this he draws an argument against them. Mr. Robinson had good sense, and a strong imagination, but he is not always to be depended upon, tho' he was far from intending to mislead his readers.

Some time ago Mr. Lindsay sent me *King's History of the Greek Church*, 4to., but having it before I sent the other to Mr. Dobson to sell for me. I wish you would inquire whether it be sold. It is a valuable work, and worth your having. I also sent him the 3d vol. of *the Transactions of the Philosophical Society at Philadelphia*, to have the 4th bound like it. Please to inquire whether it be done, and if so, let them be sent to Mr. Vaughan, who will send them hither the first opportunity.

Did you receive, and forward, my *Letter to Noah Webster?* I thank for your care of the others. (The momentary confusion in the mind of Priestley in writing the last sentence shows the advanced years or fatigue of the great man. It is a literal transcript of the original.—E. N. H.)

Yours sincerely,
J. Priestley.

Northumberland, Apr. 23, 1800.

P. S.—*The Commentaries & Essays*, is a work that you should have. There are only four Nos. of the second volume printed.

May 10, 1800.

Dear Sir:

I am sorry on your account, as well as my own, that you have forgotten your *Latin;* but certainly it is not now worth your while to endeavor to recover it. I am writing to Mr. Balsham, and I desire him to consult the passage for me. I now and then want books that I cannot get here, but in this situation I the more value those that I have, and read many that I should never have read in England, where I had greater choice, and I have found much advantage in it, so that some good results from every evil. I am now reading with much satisfaction *Bingham's Ecclesiastical Antiquities*, a learned and laborious work; but though I have long had it, I should never have done more than consult it occasionally, in any other than my present situation. For my philosophical pursuits I am nearly as well furnished as I ever was in England; but I want more early intelligence of what is doing there, and especially in France. I am much interested in the restoration of the intercourse with that country, and hope it will soon take place, unless the apprehension of a war with England in consequence of it should prevent it.

I am glad to hear you say that the *reign of terror* will soon terminate. If the *effect* cease, I shall not much mind the *cause.* On this subject, and the influ-

ence of France in this country, I differ from you *in toto;* but as it is not likely that anything I could say would change your opinion on these subjects, I shall not trouble you with it. I believe your motives to be as pure as my own, nor can I disapprove what you say of *ignorant sincerity;* but we differ widely in the application of general maxims to particular cases. I thank you for the news from New York. My correspondents there are Dr. Mitchell and Chancellor Livingstone; but our subjects are altogether philosophical. I should not have known, from anything that has come from Dr. Mitchell whether he was a Federalist or otherwise. I am glad, however, to find that he is on the *right side.*

When I look at the map, I do not think that your way to the Federal city by this place from New York is much longer than by Philadelphia. If so, I still flatter myself that you may look in upon me in going to or returning from Congress. The difference cannot be much. I would go further than that to see you.

In my last I mentioned our preservation from poison. Our physicians, however, say there was nothing but *tartar emetic* in what we took; and having examined what remained of the flour. I do not find any certain sign of arsenic in it; so that there is no proof that any serious mischief was intended.

I do not know what to think of Buonaparte, but I cannot help being apprehensive of the fate of England. By accounts from my son, the scarcity there approaches to a famine. The deaths in London are more than ever was known since the great plague. All provisions are almost three times the usual prices, and yet they will not hear of *peace.* It is like that *infatuation* which, as Hartley observes, generally precedes destruction. My consolation is that *the Lord reigneth, let the earth rejoice.*

Yours sincerely,
J. Priestley.

P. S.—I have received no letter from Mr. Dobson. I am sorry that Congress is breaking up, as you will probably leave Philadelphia, if you have not already left it.

The following letters were read by Prof. Pynchon, of Trinity College, Hartford, Ct.:—

Birmingham, June 24, 1782.

Dr. Benjamin Franklin:—

Dear Sir: You have made me very happy by your letter, as I find by it that notwithstanding the unpleasant state of politicks, your usual humor and pleasantry has not forsaken you. I am only concerned that you have not mentioned the case of my friend, *Mr. Russell,* about which I wrote you so particularly. But I have taken the liberty to assure him, that, notwithstanding this omission, I am as confident that you have not neglected the business, as if you had given me the most expressed assurance of it. One line, however, informing me what you think of the case, will give me great satisfaction.

Having at length got *sunshine,* I am busy in prosecuting the experiments about which I wrote to you, and shall soon draw up an account of them for the Royal Society.

Please to inform the Duc de Rochefecault, whose civilities to me I remember with pleasure, that my experiments are certainly inconsistent with Mr. Lavoisier's supposition of there being no such thing as phlogiston, and that it is the addition of air and not the loss of anything that converts a metal into a calx. In their usual state calces of metals do contain air, but that may be expelled by heat, and after this I reduce them to a perfect metallic state by nothing but inflammable air, which they imbibe *in toto,* without any decomposition. I lately reduced 101 ounce measures of this air to two by calx of lead, and that small remainder was still inflammable. I explain Mr. Lavoisier's experiments by supposing that *precipitate, per se,* contains all the phlogiston of the metal mercury, but in a different state; but I can show other calces which also contain more phlogiston than the metals themselves. That mercury in its metallic state does contain phlogiston or inflammable air, is evident from the production of nitrous air by the solution of it in spirits of nitre, and I make *nitrous air* from nothing but *nitrous vapor* and *inflammable air;* so that it indisputably consists of those two ingredients. I have already ascertained the proportion of inflammable air that enters into the composition of lead, tin, copper, and silver, and am proceeding to the other metals as fast as I can. When the whole is completed I shall give you a further account of it.

I am exceedingly concerned to find that it is so difficult a thing to make *peace;* but I hope before the campaign is over, all parties will have had enough of *war,* and be sensible that they will gain nothing by continuing it. If I had any voice in the business, the prospect of seeing you in this country would be a strong additional motive to accelerate the negotiations.

With the greatest respect and every good wish,
I am, dear sir, yours sincerely,
J. Priestley.

P. S.—If you should think it proper, I have no objection to your sending a copy of my former letter to *Rosier's Journal,* as a general outline of what I am doing. I wish to have every new fact to be as speedily and as generally known as possible.

London, 12 Feb. 1775.

Andrew Oliver, Jr., Esq., *Salem, Massachusetts:*—

Sir: I think myself exceedingly obliged to you, for the communication of your excellent observations on the cause of the electricity of the atmosphere. As far as I can judge of them from the general ideas you throw out, they promise to unfold that great secret of nature which has hitherto been one of the great desiderata in philosophy. I shall be very glad to see your thoughts on this subject more at large.

I have read your *Essay on Comets* with attention and pleasure. My objection, however, to your theory is, that the atmosphere of the comets being of the same nature with those of the sun and other heavenly bodies, the particles of which they consist will not be expelled by them more than by each other; so that upon their approach, they will only surround the two bodies to an equal distance. How could the atmosphere of the sun, for instance, drive that of a comet to such a distance, when no part of that of the sun itself is driven by the same power to a tenth part of the distance? But I think your hypothesis will stand clear of this objection, if you suppose, what I believe to be true, that the sun and the comets, as well as the earth, have *proper electric atmospheres,* by means of which they will be enabled to act upon their ordinary atmospheres at a considerable distance.

I rejoice much that philosophical knowledge is so much cultivated on your side of the Atlantic, and sorry I am that our attention to it will probably be called off

to a struggle for power, the most unnatural and I fear the most fatal that men were ever engaged in.

I have of late been very much engaged in the prosecution of my experiments on different kinds of AIR and have had considerable success. I intend soon to publish a *supplement* to the treatise which you very probably have heard that I have lately published without subject. If there is any intercourse between the two countries at that time, I shall send you a copy, and shall be exceedingly glad to hear from you.

I am with great respect, Sir,
Your obliged humble servant,
J. PRIESTLEY.

P. S.—L'd Shelburne desires me to present his most respectful complements to you.

NORTHUMBERLAND, April 3, 1800.

DR. B. LYNCH OLIVER:—

SIR: I do not know whether you can forgive my neglecting to answer your obliging letter of so old a date as February, 1797; when I can only say that when I received it I was from home, and not at leisure to write, and that I afterwards forgot it, and when I recollected it I was ashamed to acknowledge it. If you can, please to accept a pamphlet I take the liberty to send you on a subject that is very interesting to chemists.. I have since that completed a course of experiments in pursuance of those on *the generation of air from water*, the result of which is that, by repeated freezing of the same water, I always get from it a quantity of air, and to appearance without any limit; so that the whole might be converted into this kind of air as well as by previously converting it into vapor. By this means the atmosphere may constantly receive an addition to this ingredient in its constitution, as the other part, viz., dephlogisticated air is recruited by the influence of light on plants.

I thought I had had the volume of the American Transactions to which you refer, but I find I have no more than the first volume, but I have somewhere seen it, and I think Mr. ——— makes the difference of heat to depend upon the difference of purity in the air in different seasons. If so, he must be mistaken, for I find no sensible difference in the purity of the air at any time, or, indeed, between the air of this country and that of England.

I am not very well acquainted with the doctrines of *galvanism*, but it should seem that the different metals are in different states with respect to electricity, though it is very extraordinary that this should be the case. This is a curious and important subject just opening upon us.

I have always heard a good account of Mr. Titler, both as a man and a philosopher, but I have no personal knowledge of him.

I rejoice to find that in you that philosophy is joined to Christianity, from which it is too much separated. With me this is a primary object, and philosophy, much as I have attended to it, only a secondary one, as my writings here as well as in Europe will show.

Please remember me respectfully to your father, if, as I hope, he be still living. He is very obliging to inquire after my welfare, and assure him that I find in this country everything that I expected from it, or that I wish for in this world. I have convenience and leisure for my pursuits of every kind, and I shall endeavor to make as much use of them as I can. I want only such things as must be had from Europe, and more early intelligence of what philosophers are doing there. But this inconvenience will be removed after the present war, which cannot, I think, continue much longer, shall cease. With the greatest respect I am, sir,

Yours sincerely,
——— J. PRIESTLEY.

NORTHUMBERLAND, Aug. 8, 1800.

DR. B. LYNCH OLIVER:—

DEAR SIR: I thank you for the valuable present of Mr. Tytler's treatise. It is a very interesting work, and I shall read it with particular attention, not only on account of the principal object of it, the investigation of the nature of pestilential disorders, but on account of the great mass of collateral subjects I perceive he discusses, especially the doctrine of *heat*, concerning which I have long been unable to form any satisfactory opinion. When I have perused the work, I shall take the liberty to propose to him or to you any question that may occur to me on that subject, or any other that he has introduced. I see that in his account of plague in the appendix, he has not mentioned the most extensive and fatal of any that we read of, in that of 1348, in the time of Petrarch, which seems to have swept off one-third of the human race.

Mr. Tytler's opinion in favor of my objections to the new theory, I think of much value, and I am well persuaded that the more attention is given to the subject, the more groundless that system will appear. Many I hear suspect it in England, and there has been a serious attack made upon it in France, but by whom I have not learned. We shall soon, I hope, have a communication opened with that country, and then I shall know more particulars. The want of it at present is a great obstruction to the progress of science, but this is no object with politicians.

My experiments on the perpetual production of phlogisticated air from water, both by means of a vacuum and by freezing, I think absolutely subversive of the hypothesis of the re-solution of water into inflammable and pure air. I have made both with the greatest care, and do not at present foresee that any sufficient objection can be made to either of them; agreement with each other is a striking circumstance. Your objections to the new nomenclature are certainly very just.

The objections that Mr. Tytler makes to Count Rumford's experiments did not strike me at the time that I read them, but I shall now attend to it more particularly. I have not yet seen Noah Webster's book on the Plague, but intend to procure it. What do you and Mr. Tytler think of it? I wish we were nearer to each other.

I am, with my respects to Mr. Tytler,
Dear sir, yours sincerely,
J. PRIESTLEY.

P. S.—I have printed at my own expense *a comparison of the institutions of the Hindoos and other nations with those of Moses.* Could you assist me in the disposal of a few copies in your neighborhood?

ADDRESS AT THE GRAVE OF JOSEPH PRIESTLEY.

BY HENRY COPPÉE, LL.D.,
Of the Lehigh University.

It is known to all assembled here this evening that Professor Henry was expected to make the address on this august occasion; that the oldest and most distinguished of American scientists was to honor American science here, in honoring the memory of Priestley.

When it was announced to the committee, greatly to their regret, that Prof. Henry was prevented from coming by temporary illness, they urgently requested me to perform that duty. Although I am very much flattered by such an appointment, I have accepted it with the greatest reluctance; not because I do not venerate the name of Priestley; not because I am not ready to add my humble tribute to the ovation of this centennial gathering; but because I cannot stand in the place of Prof. Henry, and must disappoint those who have come here to listen to his counsels. I therefore crave the indulgence of all who are present for the few words which I shall utter, hastily thrown together, without materials with which to work, and without time to combine and digest such materials if they were at hand.

Fortunately, however, my task is rendered easier, or rather less important, by the masterly essays to which you have already listened. You have heard from Prof. Croft the story of his life, and the unusual severity of his trials and labors. Prof. Hunt has given us a glimpse of the colossal superstructure which has been raised upon the solid foundation, of which—strange paradox—dephlogisticated air is the chief corner-stone.

It only remains for me to draw some moral from the story and the progress, and like the preacher to point to those features of the distinguished scientist at whose grave we stand, which offer to all food for thought, models for imitation, and divine lessons of human philosophy.

The chemists as a special class have gathered in this grateful pilgrimage, but Dr. Priestley, as you have heard to-day, was more than a chemist. He was a theologian, a political economist, a civilian, a physicist, a student of history, a teacher of men.

Indeed, while objectively his great discovery in chemistry remains and will remain a wonderful fact, and a wonderful factor in chemical science, the progress of that science, since his day, has so far left behind what he knew, of principles, of material, and of apparatus, that he appears already principally as a personage in chemical *history*. Like Bacon, he pointed the way to the rich domain which he was not able to enter. So too in the broad fields of physical science, with all its varied interests, the world has moved rapidly since his day. Could he rise from this sod, and hear and see the wonders of science and the marvels of art on every side, what would be his astonishment at the photograph of his own picture which you have seen to-day; at the crowds that have came by railway expresses to do him honor; at the announcement, that under the ocean waves, the lightning, which he gloried to handle, was sending, from this Priestley centennial gathering in Northumberland, an instant flash of greeting to the crowds who three thousand miles away will make the welkin ring to-morrow with plaudits, when his statue is unveiled at Birmingham; that Birmingham which a little more than three-quarters of a century ago, sacked his laboratory, burned his house, and drove him and his children away and out of England, with a ferocious bigotry, which was not essentially English, but which belongs to human nature in all ages, and was specially characteristic of that age in Europe.

But in political economy, in jurisprudence, in ecclesiastical policy, and in history, he is still of value to the scholar and the patriot. He was a reformer, who saw in the condition and constitution of England much to be amended. The rigor of the church establishment aroused his righteous anger. He took the field against all comers: the Archbishop of Canterbury, the great orator Burke, the renowned Blackstone, the Board of Longitude; and he dictated to all, toleration and universal liberty. If he was a century in advance of his age, so much the greater his merit.

Many years ago, when I was a young student of history, there was put into my hands as one of the books to be read, a copy of Priestley's Lectures on History and General Polity. The copy which I used was published at London in 1793, the year before he came to America, and dedicated to Benjamin Vaughan, one of his favorite pupils. This book, although he says it was intended "for students and not for proficients," marks a great step in the study of modern history, and is one of a series, the other two being one on the history of England, and one on the laws and constitution of England. They were delivered while he was a tutor in the academy at Warrington. I am struck with the freshness of his inquiries; his estimate of the numismatic element; his views of the connection between history and law; anticipating Mr. Froude in his suggestion that history can only be properly written from the statute book. I would refer also to his lecture on the use which Newton made of the procession of the equinoxes in rectifying ancient chronology. His restless mind brought to the consideration of history all the new lights of science and philosophy, and suggested the modern methods of study now in use.

Of his theological opinions, I have nothing to say; we may differ from them; some of us do; we must respect them; he believed that he was right; he was right to uphold his belief against bigoted orthodoxy; he was persecuted for righteousness' sake. He came to this beautiful spot to find a refuge from political and religious storms; he found and proclaimed freedom to worship God!

At the risk of exhausting your patience, I must say a word concerning his views of education. He begins his essay on education with words which might be used by a modern educational reformer, who, without entirely discarding the old training, asks a hearing and a place for the new.

"It seems to me," he says, "a defect in our present system of public education that a proper course of studies is not provided for gentlemen who are designed to fill the principal stations of *active* life, distinct from those which are adapted to the learned professions."

"So remote," he adds, "is the general course of study at places of the most liberal education among us, from the business of civil life, that many gentlemen, who

have the most liberal education their country could afford, have looked upon the real advantages of such an education as very problematical, and have dispensed with it in their own children." We have not time to dwell upon this admirable essay; it was published in 1764, one hundred and ten years ago; but it displays such a distant forecast that it needs only a little modification to be of practical utility to-day.

Seventy years ago Priestley died in this town of Northumberland, regretting that he must abandon the pursuit of truth on earth. There was no sordid clinging to the fleshly tenement. He had the spirit of the old heroes of science and art, who fell beside their retorts, or who bowed their heads in sleep over immortal manuscripts, in which they yet wake and live and speak again in tones which sweep the diapason of the human heart.

When Prescott had conceived the plan of one of his splendid histories, he wrote to his friend Ticknor, "*Da Jupiter annos:*" years to labor and achieve. When Priestley found his life ebbing away, he only asked his physician to patch him up for six months longer, that he might complete the printing of his works.

Thus to the masters of science, overmastered at last by science, death has no terror but that of loss of usefulness in the demonstrations of truth to a needy and expectant world.

To my mind Dr. Priestley appears as always the ardent champion of truth and right. He has been called dogmatic and controversial. I think he was. If he caught, as through thick forest leaves, a glimpse of truth, no power on earth could restrain him from pursuit; it mattered not what the guise or garb; a voice within cried "follow," and drowned the expostulations of the timid, the temporizing, and the intolerant. If he saw injustice in high places or low, he must couch his lance and rush to the assault; he may have been sometimes injudicious, he seems to me to have been always honest. The spirit which prompted and pointed his opposition to injustice in England, was not burnt out when he came to America. His pen was busy when the alien and sedition laws of the elder Adams were passed, and when he, as a resident not naturalized, was exposed to their noxious application.

Thus it happened that he was a pantologist. It has been said that had he limited his attention to one subject of science or literature, he would have been pre-eminent in that.

Those have very superficially examined his character who think it was possible for him to do so. Portions of truth are found in all sciences, in all pursuits, in all ages. He would take no partial view; he seems to have desired the possession of the truth, the whole truth, and nothing but the truth; and was especially eager to observe when truth was in danger, that he might rescue her.

The great pensionary of Holland, in prison and in prospect of death, was heard muttering as words of consolation to himself in that dark hour—*justum et tenacem propositi virum.*

I like to think that a similar solace was often in the mind of Priestley, in his troubles in England, and that these words may be properly quoted in his eulogium to-day.

Priestley was a reformer. By this is meant that not only did he desire to eradicate wrong from all systems, but also to search for new methods in science and in government, which would usher in a better order. Thus the reformer becomes a discoverer; he analyzes to reconstruct, but also to discover new elements, which will give use to new and better forms of reconstruction; and in this respect his example is of great value to the young scientists of to-day. To know what is already known, to be up to the latest developments of science, is not enough to secure fame.

The man who will send his name down in the history of his science, is the one who advances it, who discovers something new; who establishes an hypothesis so that it becomes a metaphysical theory; who makes his science and the world his debtor for all time; a debt which annual or centennial instalments of gratitude will thankfully acknowledge, but can never pay off.

Such was the ardor of Priestley, and such I know to be the guiding motive, the recognized incentive, of the men who have assembled here to honor the labors of Priestley.

Brethren in the large domain of human culture, let us gather new enthusiasm at this grave. We approach this tomb not in sorrow, but in triumph; because he was a great scientist; because he brought his labors and his fame from intolerant England to a welcoming America; because he was a man of large and varied learning; because he was a righteous man, honest, true, just, and pure; and because, in honoring all these traits, we wish to place so notable an example prominently before the young men who are pursuing science in our midst.

And to our fair friends who have graced this celebration with their presence, and their kind attentions, I dare to set forth in all honor the beautiful example of Priestley's wife. She recognized her husband's gifts; she shared without a murmur his trials; she gloried in his achievements. Bearing the burden of the household, she left him uninterrupted to pursue his studies. Hear his own words: "My wife was a woman of excellent understanding, much improved by reading, of great fortitude and strength of mind, of a temper in the highest degree affectionate and generous, feeling strongly for others, and little for herself. Also greatly excelling in everything relating to household affairs. She entirely relieved me of all concern of that kind, which allowed me to give all my time to the prosecution of my studies, and the other duties of my station." My fair friends, I need not further point the moral; I cannot further adorn the tale.

This is an unusual celebration, and this particularly is the strangest scene of this singular drama. This peaceful field, an acre of God, at this most charming evening hour, happily suggested by a lady chemist; these surrounding hills, this gleaming river, which lend

breadth and beauty to the landscape; this distinguished assemblage standing reverently, but not mournfully, around a grave: these do not tell us of death, but of life; breathing, varied, sunny life; not of decay, but of resurrection; not of oblivion, but of immortality.

They tell us that in the inexorable past there is but a semblance of imprisonment; that the good and the true, the magnanimous and the noble, break the flimsy bonds, and come back to gladden the hearts of men, and to flourish in perennial beauty.

"Thou unrelenting past ——
* * * *
Alone shall evil die,
And sorrow dwell a prisoner in thy reign."

Such are the pleasant thoughts, fancies, and yet living facts, which cluster around the grave of Joseph Priestley.

A CENTURY'S PROGRESS IN CHEMICAL THEORY.

BY T. STERRY HUNT, LL.D., F.R.S.

To write the history of the progress in chemical theory during the last one hundred years would require a discussion of the growth and development of the whole of modern chemical philosophy, since the past century has seen the rise of nearly all the ideas which now find a place in our science. On endeavoring, therefore, in the hour before me, to acquit myself of the honorable task which you have imposed upon me, I can do little more than review in a rapid manner what seem to me some of the more important stages in the theory of chemistry, so that my sketch, though necessarily meagre, shall not be a faithless one. Previous to the time at which our review begins much chemical knowledge had accumulated. To that brought from the east by the Saracens had been added the experiences gathered by the apothecary, the dyer, the glass-maker, and the metallurgist, but chemistry was still an art rather than a science, and the method of the schoolmen was not favorable to the creation of a sound chemical theory. Becher and his disciple, Stahl, had, it is true, already protested against the Aristotelian philosophy, with its four elements, and had led the way to a true conception of the nature of chemical species. To the former we owe a clear definition of the distinction between bodies decomposable and undecomposable; but when this idea is further interpreted by Stahl, we find that the oxides were regarded as simple bodies, and the metals as compounds of these with phlogiston, the supposed fiery element; which was conceived to exist in a nearly pure state in carbon and in inflammable air or hydrogen. We are aware to-day that the balance gives to this phlogistic theory a formal refutation, and the fact itself did not escape Stahl, who expressly tells us that an earth or calx, by fixing phlogiston, is diminished in weight. Notwithstanding its palpable contradictions, this phlogistic theory, however, held its place for more than fifty years after the death of Stahl, and found its last defender in Priestley.

At the beginning of the century which closes with this anniversary, the curtain rises upon three illustrious chemists who, more than all others, have contributed to build up the science; it is scarcely necessary to name Scheele, Priestley, and Lavoisier. The first, wonderful in experiment and untiring in industry, discovered several bases and numerous acids, both mineral and organic, including hydrocyanic acid, indicated fluorine, made known chlorine, and recognized, almost at the same time with Priestley, the nature of oxygen and the composition of the atmosphere, of which he made an analysis. He however fell into curious errors as to the nature of the fiery principle of the air which, according to him, combined with phlogiston to produce both heat and light. Priestley, on the other hand, not less ingenious as an experimenter, and fertile in invention, devoted himself to the study of gases. Previous to his researches the only artificial gases recognized were carbonic acid and hydrogen, known as fixed and inflammable airs, to which number he added no less than nine, including hydrochloric and ammonia gases, sulphurous acid, carbonic oxide, nitrogen, and its two oxides, and finally oxygen itself; a discovery which was soon followed by the recognition of its relation to the respiration of animals. Priestley is justly called the founder of pneumatic chemistry, but, with a knowledge of oxygen and its relation to respiration and combustion, he failed to interpret aright his great discoveries, and remained till the end of his life a partisan of the views of Stahl and a believer in phlogiston. To the last he raised his voice against the doctrines of Lavoisier, and from this, his western home, sent to the French Academy of Science his protest against the new views.

Let us turn now to Lavoisier, that prodigious genius who appeared on the horizon of our century, a rising sun soon, alas! to be quenched in blood. The labors of Lavoisier extended from 1770 to 1794, and in this period we find that, not content with adding discovery to discovery till he showed himself, as an experimenter, the rival of Scheele and of Priestley, he gave laws to the science, revealed the hitherto hidden harmonies of the world of matter, and, another Newton, established upon a basis as yet unshaken the science of modern chemistry. To him, conjointly with Wenzel, we owe the systematic use of the balance in experiment, which made of chemistry a quantitative science. Repeating and verifying the researches of Priestley as to the nature of oxygen and the constitution of the atmosphere, the composition of which he established accurately both by analysis and synthesis, he next investigated more thoroughly the respiration of animals, and studied the combustion of organic bodies, which he found to yield both carbonic acid and water. The reactions between mercury and the acids which had yielded to Priestley the sulphurous and nitric oxide gases, were next studied, and the quantitative relations of these reactions determined. The nature of water, which appeared in so many processes of combustion, then engaged his attention, and he shares with Cavendish the merit of the independent discovery

of the composition of water, which was quantitatively determined by him both analytically and synthetically. At last, after years of careful investigation, controlling alike his own discoveries and those of his contemporaries with the aid of the balance, Lavoisier had firmly established the bases of his grand theory, which he now gave to the world, demolishing the phlogistic hypothesis of Stahl, showing the simple nature of oxygen, its union with the metals to form calxes or oxides, and with sulphur, phosphorus, and carbon to generate acids. The true natures of the metals, earths and acids, of air and water, and of organic bodies were determined, the phenomena of fermentation, combustion, respiration, and animal heat were explained, and the new chemistry was created. In the various transformations of matter it was shown that there was nothing lost and nothing gained, and no place was left for the imaginary phlogiston. We here find reiterated and justified by modern discovery the old doctrine of the Egyptian philosophers, preserved to us in that wonderful book known by the name of Hermes Trismegistos, where it is written: "Nothing perishes, nothing is destroyed, but that which is composite divides itself, and life consists in an incessant and necessary transformation." The more we look at the chemical work of Lavoisier the more we marvel at his genius, at his unerring judgment, and the breadth of his vision, and if we follow him into the domain of chemical physics his generalizations are not less wonderful. He, however, left a great work for his followers.

All things, says the sage, are ordered by weight, by measure, and by number, yet with the balance in hand Lavoisier does not seem to have comprehended this grand truth, although his quantitative determinations of the composition of water, both by weight and by measure, really furnish a striking example of it. The nature of the saline combinations formed by the union of acids with bases was, in like manner, but little studied by Lavoisier; and it was Wenzel, whose researches in chemical affinity appeared in 1777, who made known the important facts that in the double decomposition of neutral salts the resulting compounds are neutral, and that the elements of the two salts employed are found complete in the products of the reaction, so that here again nothing is lost and nothing gained. Carefully controlling all his experiments by weighings, he laid the foundation of chemical statics. The succeeding researches of Richter and of Proust established the numerical relations between combining bodies, and thus prepared the way for the great generalizations of Dalton, who, in 1807, summed up the long labors of Wenzel, Richter, Proust, and his own in his theory of definite and multiple proportions. Dalton, as you are aware, linked his discoveries with the old hypothesis of the atomic constitution of matter, which is, however, by no means necessarily connected with the great laws of combination by weight and by number. It was reserved for Gay-Lussac to make known a not less beautiful generalization, by showing that in the combination of vapors and gases there exists an equally simple relation of volumes, and that measure, not less than number and weight, governs all chemical changes.

The combining proportions of the elementary bodies, when compared with oxygen, as was done by Berzelius, exhibited no simple relations among each other, but when hydrogen was taken as unity such relations appeared as led Prout to conjecture that some law, like that which regulated the equivalent weights of admitted compounds, would be found to prevail among so-called elements, and, moreover, that they were all multiples of hydrogen by some whole number; a conclusion, however, which seemed irreconcilable with the most careful determinations of equivalent weights. On the other hand, the curious numerical relations between the equivalents of bodies of similar chemical character attracted strongly the attention of chemists. As early as 1829 Dobereiner called attention to the triads of related bodies, such as the groups of lithium, sodium, and potassium, and of calcium, strontium, and barium, in which the equivalent weight of the middle term is the mean of that of the extremes. Almost simultaneously, and apparently independently, Pettenkofer and Dumas took up again the question, in 1851, and called attention to the fact that the numerical relations between these and many other mineral radicals are similar to those between the organic radicals known to result from the condensation of successive equivalents of carbon and hydrogen, such as the olefines, the paraffines, and the alcohol radicals. The possibility that the mineral radicals, related alike in chemical characters and in equivalent weights, might, also, be composite bodies, was suggested by Dumas in 1857, and with this in view he undertook a re-examination of the equivalent weights of the elements. If, as the numbers adopted by Berzelius seemed to show, no simple ratios existed between those of related elements, the suggestion of Dumas was inadmissible; but if, on the contrary, as supposed by Prout, a simple and exact relation of this kind was established, it was not impossible that the view of their compound nature might be true.

The results of many years of patient labor, devoted to a re-examination of the equivalent weights of a great number of bodies, were given to the world by Dumas in 1859, and from these he concluded that the law of Prout is so far true that the equivalent weights of the elements are multiples of a unity which is one-fourth that of hydrogen; so that, if H = 1, we shall still have such fractions as Cl = 35·5, and Al = 13·75. These results and the analogies between the elements of mineral and of organic chemistry, both in chemical relations and in equivalent weights (which in the mean time had been carefully investigated and developed by J. P. Cooke), now led Dumas to reaffirm his conjecture that the mineral radicals may really be compounds, though their decomposition is perhaps beyond the possibilities of our chemical analysis.

Among the most significant advances in chemical theory are those relating to the action of heat on bodies. If we define chemistry, as I have been tempted

to do, as that science which treats of the relations to one another of the different forms of mineral (*i. e.* unorganized) matter, and their transformations under the physical agencies of heat, light and electricity, we shall see how difficult it is, in a sketch like this, to draw the line between physics and chemistry. This becomes still more evident when we see in light the chemical constitution of matter, as it were, revealed and made visible to us by the spectroscope, or study the electric current parting in a mysterious manner the components of bodies. Time would fail us to follow the trains of thought thus opened, but I cannot forbear to say somewhat of the relations of temperature to chemical species, and of the power of heat to unloose the bonds of chemical combination. The admirable researches of Grove, followed by those of Henri St. Claire Deville and his fellow-laborers, have shown us that at an elevated temperature such bodies as water, hydrate of potassium, and hydrochloric acid are more or less completely resolved into their constituent elements, the affinities of which are suspended. In this principle of dissociation by heat we have an explanation of many chemical reactions hitherto enigmatical. The decomposition of bodies by heat is, moreover, assimilated to the phenomenon of volatilization; the rate of decomposition at a given temperature varying with the pressure, and with the nature of the atmosphere which surrounds the unstable body. The phenomena of dissociation are seen in a wonderful degree in the sun, the fixed stars, and the nebulæ. It is not necessary to recall to you the marvellous field of celestial chemistry which the spectroscope, in the hands of Kirchoff and his followers, has made known to us, nor to the proofs that the solar atmosphere contains in a dissociated state very many of the elements which in our own planet are met with in a free state only in the laboratory of the chemist. It is instructive to compare the spectra of the various fixed stars with each other, from white stars like Sirius, to yellow stars like Aldebaran and our own sun, and red stars like Alpha Orionis and Antares, and to note in these three classes an increasing complexity of chemical composition. In the first, with a predominance of hydrogen, we see only faint lines of magnesium, sodium, calcium, iron, and a few other metals, while in the second, though free hydrogen still abounds, the number of metallic elements is greatly augmented, and finally in the red stars hydrogen is seen only in combination, as aqueous vapor, the metals are wanting, and the metalloids and their compounds appear. If, in accordance with the nebular hypothesis, we look upon these different types of stars as representing successive stages in the process of condensation from nebula to planet, we may also see in them a gradual evolution of the more complex from the simple forms of matter by a process of celestial chemistry. Such was the view put forward by F. W. Clarke in January, 1873, and some months later by Lockyer, who has reiterated and enforced these suggestions, and moreover connected them with the speculations of Dumas on the composite nature of the elements. The white stars are the hottest, and in the atmosphere of these bodies the various metals, according to Lockyer, make their appearance in the order of their vapor-densities.

I ventured in 1867, while speculating on the phenomena of dissociation, to remark, that, although from the experiments of the laboratory we can only conjecture the complex nature of the so-called elementary substances, we may expect that their "further dissociation in stellar or nebulous masses may give us evidence of matter still more elemental." Now, while the nebulæ when scanned by the spectroscope show us only the lines of hydrogen and nitrogen, the two lightest forms of gaseous matter known to chemistry, it is remarkable that the recent studies of the solar chromosphere reveal to us the existence of an unknown gaseous element which, from its extension beyond even the layer of partially cooled hydrogen; must, according to the deductions of Mr. Johnson Stoney, be still lighter than this gas. The green line by which this substance is distinguished is not as yet identified with that of any terrestrial element. Is it not possible that we have here that more elemental form of matter which, though not seen in the nebulæ, is liberated by the intense heat of the solar sphere, and may possibly correspond to the primary matter conjectured by Dumas, having an equivalent weight one-fourth that of hydrogen? Mention should also be made of the unknown element conjectured by Huggins to exist in some nebulæ. This conception of a first matter or *Urstoff* has also been maintained by Hinrichs, who has put forward an argument in its favor from a consideration of the wavelengths in the lines of the spectra of various elements.

It is curious in this connection to note that Lavoisier suggested that hydrogen, nitrogen, and oxygen, with heat and light, might be regarded as simpler forms of matter from which all others were derived. The nebulæ, which we conceive as condensing into suns and planets, show us only two of the three elements of our terrestrial envelope, which is made up of air and aqueous vapor. If now we admit, as I am disposed to do with Mattieu Williams, that our atmosphere and ocean are not simply terrestrial but cosmical, and are a portion of the medium which, in an attenuated form, fills the interstellary spaces, these same nebulæ and their resulting worlds may be evolved by a process of chemical condensation from this universal atmosphere, to which they would sustain a relation somewhat analogous to that of clouds and rain to the aqueous vapor around us. This, though it may be regarded as a legitimate and plausible speculation, is at present nothing more, and we may never advance beyond conjecture as to the relation of the various forms of so-called elemental matter, and to the processes which govern the evolution of the celestial spheres. You will, I trust, pardon this excursion to the regions of space and the realm of imagination into which I have led you, and return with me to the consideration of a new chapter in chemical theory.

It soon became evident from the researches of Lavoisier, and the subsequent ones of Berthollet, that from

the four elements, carbon, hydrogen, oxygen, and nitrogen, are compounded the various products of the vegetable and animal kingdoms, and with the study of these compounds grew up the so-called organic chemistry. So long as the results of the ultimate analysis of these bodies were represented centesimally, their constitution remained obscure, but slight variations in composition being found between species widely unlike in chemical and physical properties. When, however, in accordance with the law of equivalents, it was possible to construct from their analyses formulas for these bodies, and when for volatile compounds, like alcohol and ether, Dumas had applied Gay-Lussac's law of volumes, by determining the density of their vapors, the foundation of a rational system of organic chemistry was laid; and the conception of types, in which one element could be replaced by another, was introduced into the science by Dumas. The multiplication of similar bodies, like the alcohols and their related acids, with varying equivalents and vapor-densities, led to comparisons which soon resulted in the conception of series. It was found that if spirit of wine could be regarded as a hydrate of olefiant gas, other related bodies were hydrates of other hydrocarbons having the same centesimal composition as it, but more or less condensed. It thus became possible to represent bodies so related in composition and properties by a common formula, as members of a series, differing by nCH_2. The first conception of this great step belongs to Dr. James Shiel, of St. Louis, and was afterwards systematically carried out by Gerhardt, who gave to bodies so related the name of chemical homologues.

But here arose another question: Guyton de Morveau had in his first essay at a chemical nomenclature, in 1782, ranged alcohol with lime, silver, and phlogiston, as a base capable of saturating acids, thus assimilating the ethers to salts, and when in the light of modern chemistry these ethers were further studied, spirit of wine was described not as a hydrate of olefiant gas, C_2H_4, but as a hydrated oxide of ethyl, comparable to hydrate of potassium, in which the group C_2H_5 played the part of potassium. Here was a hydrocarbon group assimilated to a metal—an electro-positive compound radical, in the language of Berzelius; while in cyanogen was found another group similar in its relations to chlorine—an electro-negative compound radical. You are aware of the extent to which this new view was carried, and how the analogies of the mineral oxygen-acids led to the extension of a similar view to the organic acids, so that vinegar was said to be the hydrated teroxide of a hydrocarbon-radical, acetyl, and in accordance with the binary theory of salts, the acetates were compounds of an anhydrous acetic acid with a metallic oxide. Organic chemistry was defined by Liebig to be the chemistry of compound radicals, and soon this notion was carried into mineral chemistry also. The analogies between the compounds of chlorine (the so-called haloid salts), and the salts of oxygen-acids, led to an attempt to assimilate these latter to the type of the haloids, and in place of the old conception of salts made up of bases and acids, we had that of a new series of radicals, oxynitrion and oxysulphion, the analogues of chlorine and iodine, forming acids with hydrogen. The excesses to which this doctrine of compound radicals was carried, however, provoked a reaction, and the unitary system of Laurent and Gerhardt arose, from which all notions of base and radical, or of oxide and acid were excluded. A chemical compound was regarded a unity, in which the conception of dualism found no place; a great advance in chemical theory. In such a compound, if a salt, the equivalent substitution of one metal for another involved no hypothesis, but was a simple statement of a fact, and from this notion to that of the substitution for an element of a group of elements (the so-called compound radicals), was but a step; so that by formulas constituted in accordance with the unitary system, it becomes possible to give an intelligible view of the constitution of bodies, which no dualistic formulas could represent. The doctrine of types, first enunciated by Dumas, advanced by Laurent, and perfected by the labors of others, may be said to be the basis of our present chemical theory. It was the conception of the dual water-type which first rendered clear the theory of ethers and anhydrous monobasic acids, and thence the generation of bibasic and tribasic acids, whose derivation from the water-type I taught as early as 1848, some years before these views were accepted by Williamson and Gerhardt, whose names are generally associated with this extention of the original doctrine of Dumas. What I regard as a misconception of its use has been taught by some chemists, who imagine a double or triple water-type, in which, as in the case of the phosphoric acids, a divalent and a trivalent radical replace respectively two and three equivalents of hydrogen, thus giving rise to bibasic and tribasic acids. We have rather, I conceive, first a reaction between phosphoric pentoxide and water, giving rise to the monobasic acid, which in its turn reacts with a second equivalent of water to generate the bibasic acid, from which again the tribasic acid is produced by reaction with a third equivalent of water. Such is the natural process of the generation of these polybasic acids, while, as I have elsewhere endeavored to show, the extension of the other view to the so-called subsalts (which, as long since pointed out by Gerhardt, are truly neutral polybasic salts), forces us to admit, for certain basic sulphates and chlorids, polyatomic radicals which are mere algebraic expressions, containing negative quantities. The radical theory here fails, and our system of notation based upon it is found inadequate to represent all the cases of chemical operations.

A so-called rational formula is constructed with a view of rendering intelligible a certain class of reactions; while from other points of view other rational formulas are equally admissible. In all of these formulas we are striving to express the relations between a given body, on the one hand, and those from which it has been derived, or those into which it may be resolved, on the other, and the possibilities of generation are such that no one formula can adequately represent all the

changes observed. By the use of what are called dissected or structural formulas it becomes possible to include a wider range of transformations, but even here it is found that different reactions in some cases lead to different final dissections, as has been lately well pointed out by Wright, thus showing the inadequacy of these formulas also. These considerations led me in 1853 to insist that "the notion of pre-existing elements or groups of elements," should find no place in the theory of chemistry, and "that of the relation which subsists between the higher species and those derived from them we can only assert the possibility, and under proper conditions the certainty, of producing the one from the other." Of our rational formulas we may say, in the language of Gerhardt, that they "are not intended to represent the arrangement of the atoms, but to make evident in the simplest and most direct manner the relations which connect bodies with one another in their transformations." Thus understood, and with these reserves and limitations, they have an important place in chemical teaching.

The study of water in its relations to organic bodies soon showed that it must be regarded as containing two equivalents of hydrogen combined with a single proportion of oxygen, the weight of which was hence not eight, as it had previously been regarded, but sixteen, hydrogen being unity. From this bibasic or dual type of water flows the conception of the bivalency of oxygen. The doubling of the equivalent weight of carbon followed as a consequence, and the study of its compounds showed that this element, with an equivalent weight of twelve, was quadrivalent. Henceforth the different saturating powers of the elements became a recognized principle in chemical theory.

The increase by regular increments of carbon and hydrogen in the compounds of organic chemistry was a remarkable extension of the principle which underlies the theory of definite and multiple proportions. This condensation of matter appears alike in homologous series, and in polymeric compounds not homologous, and finds further illustrations in the polymerism of the elements, as shown in the different modifications of oxygen, phosphorus, and carbon; in which we find bodies of very unlike physical and physiological characters generated from the same elementary species, and sometimes carrying their modified condition into their combinations, as appears in the singular chemical relations of the graphon and graphitic acid of Brodie. In vapors the density varies as the equivalent weight, the volume being a constant quantity, and it would appear that, at least within certain limits and for species of related crystalline forms, this is true of solids. Were this true for all solid species, it is obvious that we should be enabled to find the relative equivalent weights of these modifications of phosphorus and carbon. By the comparison of these with substances known to possess a high equivalent weight, as, for example, some organic bodies, it would even be possible to fix that of these elemental species, which would certainly be found to have a very elevated equivalent, indicating a high degree of polymerism.

If now we extend this view to compound species like the natural silicates and carbonates, we shall find many evidences of a similar polymerism. The elevation of the equivalent shows itself not only in augmented density, but in increased hardness and greater chemical indifference. Examples of this are seen in silicates like meionite and zoisite, and also in carbonates like calcite, dolomite, and magnesite, to which I have been led to assign, provisionally, equivalent weights including not less than fifteen and twenty equivalents of carbon.

But apart from the polymeric condensation, which appears alike in elemental and in compound species outside of the domain of organic chemistry, we may also in mineral bodies find relations similar to those presented by the hydrocarbon series in which the first term is unlike the common difference, and we shall even recognize, in these, evidences of chemical homology, showing itself in similar crystalline form and in related physical properties. Examples of this are seen in many mineral species, which differ from each other in their varying proportions of water and protoxyd bases. The polymeric isomorphism of Scheerer here finds its place, and the relation seen in certain bodies of varying composition and constant crystalline form, which Cooke has designated allomerism, its natural explanation.

But while we thus increase our knowledge of the transformations of matter, and multiply compounds, while the marvellous methods of synthesis now enable us to build up from elemental carbon and hydrogen the most complex bodies of the carbon series, at will; while the method of diffusion through membranous septa is giving us a clearer conception of that delicate and subtle chemistry which works in the vegetable and animal organisms, there is a question lying behind and beyond all this which demands our attention, which is the essential nature and the mode of chemical operations. The phenomena of chemistry lie on a plane above those of physics, and, to my apprehension, the processes with which the latter science makes us acquainted can afford, at best, only imperfect analogies when applied to the explanation of chemical phenomena, to the elucidation of which they are wholly inadequate. In chemical change the uniting bodies come to occupy the same space at the same time, and the impenetrability of matter is seen to be no longer a fact, the volume of the combining masses is confounded, and all the physical and physiological characters which are our guides in the region of physics fail us, gravity alone excepted; the diamond dissolves in oxygen gas, and the identity of chlorine and of sodium are lost in that of sea-salt. To say that chemical union is, in its essence, identification, as Hegel has defined it, appears to me the simplest statement conceivable. The type of the chemical process is found in solution, from which it is possible, under changed physical conditions, to regenerate the original species. Can our science affirm more than this, and are we not going beyond the

limits of a sound philosophy when we endeavor, by hypotheses of hard particles with void spaces, of atoms and molecules, with bonds and links, to explain chemical affinities, and when we give a concrete form to our mechanical conceptions of the great laws of definite and multiple proportions to which the chemical process is subordinated? Let us not confound the image with the thing itself, until, in the language of Brodie, in the discussion of this very question, "we mistake the suggestions of fancy for the reality of nature, and we cease to distinguish between conjecture and fact." The atomic hypothesis, by the aid of which Dalton sought to explain his great generalizations, has done good service in chemistry, as the Newtonian theory of light did in optics, but is already losing its hold on many advanced thinkers in our science. Williamson admits that the conceptions involved in this hypothesis "are not raised in chemistry by any evidence whatever," and Wright, in a late essay, has done good service by defining its true relations to our modern notation; while Brodie, in his Calculus of Chemical Operations, has pointed out the way to a higher chemical philosophy.

THE CENTURY'S PROGRESS IN INDUSTRIAL CHEMISTRY.

BY PROF. J. LAWRENCE SMITH,
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Chemistry was an art long before it was a science. But it was not until Priestley had discovered oxygen, and Lavoisier became the interpreter of chemistry with his great analytical mind, and the balance in his hand, did the daylight of chemistry truly dawn upon the world; previous to that time all was dim twilight, little better than darkness. When Lavoisier made the study of quantity an important element in chemistry, followed by Dalton's discovery of chemical proportions, then the inventive genius of mankind made chemistry a useful and certain servant, and built up one industry after another. As an art it has a pre-historic date; for whatever of the arts furnished products resulting from changes in the materials that nature furnished, and were produced by the reaction of one substance upon another, properly ranks as a chemical art; but it never began to assert its dignity as such until the sixteenth century, when that rude specimen of a scientific reformer, Paracelsus, undertook to deal with his contemporaries in a language more forcible than elegant, and in his violent denunciation of the medical men of his day he says:—

"After having studied Hippocrates, Galen, and Avienne, you think that you know everything, but you absolutely know nothing; you prescribe medicines, and you are ignorant of the method of preparing them! Chemistry it is that solves all problems of physiology, pathology, and therapeutics; outside of chemistry you only grope in the dark."

"Your Prince Galen is in hell; and if you knew what he had written to me from that place, you would make the sign of the cross with a fox's tail. Your Avienne is at the threshold of purgatory. O hypocrites! you will not listen to the voice of a physician instructed in the works of God; and after my death my disciples will expose your impositions, and show you to be but poisoners of Christian princes and gentlemen.

"Speak to me rather of chemists; they are not a lazy set such as you are, and are not clothed in velvet and silk, with rings on their fingers, and white gloves on their hands. They work night and day to get at their results; they do not frequent places of amusement, but pass all their time in the laboratory, and wear soiled clothes, are not afraid of burning and soiling their fingers with fire or filth; they are as black and sooty as blacksmiths and coal-heavers."

This was Paracelsus's theme, drunk or sober, and if history be correct, he was only sober when not in the first condition. In vigor and boldness he was a reformer of the type of his cotemporary Luther.

And from the age of Paracelsus, we may fairly date the epoch of that reform in the chemical art, which in the latter part of the eighteenth century culminated in the present *science of chemistry*, the result of hard labor and much self-denial.

All that is asked of me on this occasion is a review of a century's progress in industrial chemistry; to do this in an efficient manner, requires more time than is given to the celebration of this memorable occasion; to treat it otherwise, is but to give an imperfect enumeration of the wonderful applications of chemistry to those arts which have added so much to the prosperity, wealth, and well-being of the civilized world during the nineteenth century, which latter I must content myself with. In fact, industrial chemistry links itself with every modern art in such an intimate manner, that were we to take away the influence and results of chemistry, it would be almost like taking away the laws of gravitation from the universe. Industrial chaos would result in one case, as material chaos would in the latter. The miner, the metallurgist, the machinist, the weaver, the paper-maker, the painter, the glass-maker, the fine arts, all draw from the rich storehouse of chemistry. To these we must add the new arts born directly from the same source, viz., photography, galvanoplasty, gilding and silvering metals, dyeing with new colors obtained from coal, vulcanized India-rubber, stearine candles, sugar from starch and wood, etc.

No one can paint in too vivid colors the sum of the indebtedness the civilized world is already under to the chemist, and no enthusiast can transcend in his wildest speculations what we are yet to realize. The chemical arts in their strictest sense do not simply aid the other arts, but they keep in activity a vast amount of capital, and consequently give employment to a large number of individuals, skilled and unskilled. In France

* Much that is contained in this paper I have written at other times, when one or other of the subjects embraced had to be discussed by me. J. L. S.

alone, the annual value of chemical products is over $250,000,000, of which $125,000,000 represents the articles of sulphuric acid, soda, soap, India-rubber, and candles. Of chemical products, France exports $20,000,000 worth, the remainder being consumed at home in giving activity to other industries whose products are largely exported in the form of woollen, cotton, and silk stuffs, etc.

The above statement represents the activity of industrial chemistry in but one country, yet every part of the civilized world is more or less engaged in the manufacture of chemicals.

It is not an easy matter to decide in what order to review the details of its progress, whether chronological or otherwise. I have, however, thought it best to adhere more or less to the former, without binding myself strictly by it. So I will call your attention first to the industrial chemistry of oxygen and chlorine, both elements of 1774.

Oxygen.

Oxygen, we are well aware, was first formed from dissociation of the elements of oxide of mercury through the agency of heat, and from that time to this most of the processes for obtaining oxygen have this for their basis. There are no less than eleven methods of producing this gas practically.

1. By heating oxide of mercury—Priestley in 1774.
2. " " red oxide of lead.
3. " " nitrate of potash.
4. " " peroxide of manganese.
5. " " chlorate of potash.
6. " " sulphuric acid to a red heat. } St. Clair Deville and Daubray.
7. " " binoxide of baryta. }
8. " " oxychloride of copper.
9. " " manganate of soda in the presence of steam—perfected by Tessie du Motay.
10. By decomposing chromic acid with sulphuric acid.
11. " electrolysis.

But of all of these processes, only two or three of them may be said to belong to the domain of industrial chemistry, viz., heating chlorate of potash, sulphuric acid, oxychloride of copper, or manganate of soda.

For producing pure oxygen, the former is the one most commonly employed; for an impure oxygen, but costing much less, the latter method, by permanganate, is employed. There is one other development connected with oxygen during the past century: it is that of Schönbein, of giving to it a condition different to its ordinary one, approximating much nearer to chlorine than ordinary oxygen, and known under the name of ozone.

As yet oxygen in either of its conditions has received but limited application in the arts, but as the ready and economical method of producing it is of but recent origin, we must wait for the development of its industrial application. And my conviction is, that the day is not far distant when Priestley's name will not only be connected with the discovery of the corner-stone of modern chemistry, but will also be associated with one of the most useful agents in the chemical arts. Its most important application is to the fusion of platinum in conjunction with hydrogen or hydro-carbon gases, and within the past few months a large ingot of 500 pounds of the alloy of platinum and iridium (used for making the standard meter for the different European and American governments), was fused by its use; in fact, no other known method could have been applied to give the required uniformity to the above alloy.

Chlorine.

I now pass to chlorine, to which this celebration belongs almost as much as it does to oxygen, and none of us can hear the name of Priestley pronounced, without our associating it in our mind with that of Scheele. To chemical industry and to the development of some of the most useful arts, the importance of the discovery of chlorine cannot be overrated.

When Scheele first described it, he seems to have studied all its properties, and left nothing for future chemists to develop, under this head, except his misconception of its true chemical position; which, of course, in no way affected the results of his investigation with reference to its reactions. The one property, however, which makes it so important an article in chemical industry, is its power of destroying organic coloring matter, by what is by many supposed to be an indirect process of oxidation. Thus the two elements discovered by the two great contemporaries, Scheele and Priestley, interweave themselves in their useful effects.

The present advanced condition of the art of bleaching was not the growth of a day. The following is a short summary of its growth. Berthollet in 1785 observes that an aqueous solution of chlorine, which had been discovered by Scheele in 1774, possessed the power of destroying vegetable colors, in the same manner as the gas itself. Berthollet showed the process to Watt at Paris in 1786, and Watt on his return to Scotland tried the plan on 1500 yards of linen in the bleach-fields of his father-in-law near Glasgow. It was brought under the notice of the bleachers at Aberdeen by Professor Copeland, and was introduced at Manchester about the same time, chiefly through the labors of Dr. Henry. It was soon found that the texture of the goods was injured by the action of the chlorine, and that the workmen were much affected by the gas. Berthollet obviated these difficulties in a great measure by adding potash to the water, and Henry followed by substituting lime. About this period, the eminent manufacturer, Mr. Tennent, to whom we are indebted for the adaptation of this valuable agent to all the purposes of bleaching, took out his first patent for the manufacture of a saturated solution of chloride of lime, which he superseded by another patent, 1799, for the dry chloride of lime or *bleaching powder*, and this last we may regard as the greatest advancement since the discovery of chlorine, towards rendering it available in the arts, for it can now be transported readily to all parts of the world, and,

moreover, we are indebted to this form (so to speak) of chlorine for the discovery and manufacture of that great boon to suffering humanity, viz., chloroform.

As regards the manner of making chlorine, no process has been devised since that of Scheele that is more ready or more economical, viz., the reaction of black oxide of manganese on chlorhydric acid or its equivalent, a mixture of common salt and sulphuric acid. Various processes have been devised for oxidizing the chlorhydric acid by mixing its vapor with air, and passing it over red-hot surfaces, but as yet none of these processes are adopted.

Let us see what chlorine has accomplished in its industrial application during the past century. Commencing with the agriculturist, it has stimulated the growth of cotton, and I believe that I am within bounds when I say that $100,000,000 less of cotton would be made and sold in this country than is now the case, had chlorine not been discovered; a vast amount of the mineral wealth, in the shape of coal and iron, that has now enriched England for the past century, would have been still dormant in her mines, the buzz of the spindle, and the ceaseless racket of the loom, would have been far less than what it is; and why?

It is not sufficient simply to spin and weave cotton to make it useful for the purposes of comfort and luxury —the cotton fabric as it comes from the loom is but a dingy and unsightly stuff—it must first be rendered as white as the driven snow before it becomes fitted for many of its uses. This in former times, as is well known to us all, was done by the agency of the oxygen of the air, the stuff being spread out on the greensward, or hung on rails, and moistened with water, a process requiring days and months, and a large surface of territory.

Chlorine has revolutionized this, and a few hours accomplishes that which formerly required days; and a few hundred square feet, containing properly constructed vats, takes the place of thousands of acres of land. Thus the civilized world has been able to use four or fivefold the amount of cotton than it otherwise would have done, and millions upon millions of acres of territory saved to the cultivation of grain and other necessities of life.

Perhaps I do not exaggerate when I say that one-twentieth the cultivatable territory is saved in England through the agency of chlorine, on the assumption that it could manufacture cotton, to the amount that it does, without chlorine.

So then, all hail to the industrial power of *Scheele's chlorine*, by its reaction on water developing the *oxygen of Priestley*. If chlorine has done thus much in the past century, she has a host of assistants around her scattering their beneficient influences, although the principal one savors strongly of brimstone.

Sulphuric Acid.

I allude to sulphuric acid, which cannot be said to have been known for more than three or four hundred years; but the industry, as it now exists, belongs to this century.

The process of manufacturing this acid, by the combustion of sulphur, now employed, is an English invention, and dates back to the early part of the last century. The first great improvement in its manufacture, during the past hundred years, was made by Dr. Roebuck, of Birmingham, in 1786. It consisted in the substitution of leaden for earthenware vessels, and all subsequent improvements in apparatus have been based upon the increase of the size of the recipient vessels, and improvements in the apparatus for burning the sulphur, and the manner of applying the nitric acid to the sulphurous acid, until the lead vessels have become immense lead chambers, and the apparatus for burning the sulphur have become furnaces.

Improvements of a secondary character, but yet of very great importance, have been added to the above. The principal one of these is the substitution of iron pyrites FeS_2 for sulphur, and the other is the substitution of platinum for glass vessels in the concentration of the acid.

The first use of pyrites is claimed for two parties, Dr. Manson and Mr. Hill. While the use of iron pyrites in the manufacture of sulphuric acid dates back prior to 1830, it was not until 1838 that the short-sighted policy of the King of Naples, in granting the monopoly of Sicilian sulphur to Messrs. Faix & Co., of Marseilles, fairly established its use, for the price of sulphur rose in England from $25 to $70 a ton; and in twelve months from that time, in England alone, not less than fifteen patents were granted for the manufacture of sulphuric acid from pyrites.

And although the monopoly was soon withdrawn, by the persuasion of English vessels of war, and the diplomacy of other governments, the pyrites had secured a firm footing in supplanting sulphur in the manufacture of sulphuric acid; and since then its use has rapidly increased, giving a wholesome lesson to governments to exercise great caution in granting monopolies, and in legislating so as not to thwart industries based upon a science that draws brilliant dyestuffs from coal, and is not to be confined in the manner and methods of its creations, so long as the elements in one shape or another are at its command.

Since the first production of sulphuric acid from pyrites, the establishment of Fahlun, in Sweden, has employed this process altogether, pyrites being very abundant in that locality. This example was followed by Perret, of Chessey, France, where the pyrites contain from three to four per cent. of copper, which metal can only be extracted by desulphurizing the ore. From the mines of this locality seventy thousand tons of pyrites are used and exported annually, and the various lead chambers here for making sulphuric acid have a capacity of about 1,600,000 cubic feet. This process is carried on in all parts of France, whether the pyrites contain copper or not; and Sicilian sulphur is only employed for special purposes in France and England. I

would here remark that so perfectly can the pyrites be now burnt, that there need not remain over one per cent. of sulphur in the residue.

It is not to be supposed, however, that sulphur is henceforth to be excluded from the manufacture of sulphuric acid; on the contrary, it is more than probable that many factories will return to its use, as the sulphur in Sicily is almost exhaustless; and if ever the country becomes opened to the world by good and numerous roads, the price of sulphur must diminish, and the diminution required is very small to bring it again into more common use among the acid manufacturers of the world.

The factories in Belgium, in the north of France, and in some other parts of that country, those in Germany, and a number in England, will find it profitable in almost any state of the case to continue the use of pyrites.

As regards the concentration of the acid, the great cost of platinum vessels is a serious drawback in its manufacture, but we are none the less indebted to the use of these vessels for the cheapening of the acid. Glass can be used in some places advantageously.

Efforts are now being directed to perfect a method of concentrating in vacuum, by which lead vessels can be used; but, up to the present time, with only partial success. Döbereiner's suggestion of making sulphuric acid in very much smaller apparatus than that now used (by the agency of sulphurous acid, air, and spongy platinum), has been tried and worked successfully on a small scale, and its extended success belongs to the future of chemistry; the minor improvements, such as recovering the nitrous acid, etc., do not properly form a part of the review of the subject for such an occasion as this.

Bisulphide of Carbon.

Besides the use of sulphur for sulphuric acid in the chemical arts, it has of latter years been employed to no inconsiderable extent in making bisulphide of carbon, which is now manufactured on a very large scale, especially by the improved arrangement of apparatus of M. Deiss, placing a battery of four fire-clay cylinders, five feet high by twenty inches in diameter, into one furnace, and producing it at a cost of five cents per pound. Other forms of apparatus, however, are used to advantage. Some idea of the extent of its production may be inferred from the fact that several manufacturers make over a half ton each per day. It is used principally for dissolving and softening caoutchouc in the process of vulcanization; in the gutta-percha manufacture; in extracting bitumen from minerals by a process invented by M. Moussu; in extracting fat and oil from bones, oil cake, etc., sheep's wool, greasy refuse stuff, as cotton waste, etc.; also used for the extraction of the aromatic principles of spices and other odoriferous plants, and, when perfectly pure, it is said that it can be used for extracting the most delicate perfumes from plants and flowers, without injuring the odors. It has also served as an agent for producing motive power, owing to its low boiling point, and engines have been worked successfully by it. In fact, much may be expected of it from its extended use in the future.

Soda.

From sulphuric acid my subject naturally glides into the history of the Industrial Chemistry of Soda, and, in referring to its origin, I will use the words of Hofmann and Ward: "The ever memorable discovery, by the illustrious Le Blanc, of the process now everywhere in use for manufacturing carbonate of soda from common salt, stands distinguished in the annals of industry, not only as by far the most important of all chemico-industrial inventions, but also (a signal fact) of having been created perfect. All the other great chemical industries have been slowly worked out by the toil of successive inventors, but Le Blanc's process, the greatest of them all, remains to this day, what it was when he first gave it to the world, the best and simplest method of effecting the most valuable of all known transformations. Though eighty-six years have elapsed since this splendid discovery was made, and innumerable researches have been undertaken with a view to its improvement, the original indications of Le Blanc are all but universally followed, with merely a few comparatively unimportant modifications.

"It might have been expected that a process which, at its first introduction, was examined by a government commission of thoroughly practical men, and which, after having been submitted to comparative experiments, made with the greatest care, was recommended in an elaborate official report, would have been almost immediately adopted throughout Europe, with proportionate advantage to its discoverer. Such reasonable hopes, if entertained by Le Blanc, were destined to cruel disappointment. Le Blanc himself never reaped the reward of his admirable discovery.

"This man, who was certainly one of the greatest benefactors of his race, and to whom, long since, France and England should have joined to raise a statue, lived in poverty, and died in despair. The creator of incalculable wealth for his species, he wanted bread himself; and, after endowing man with cheap soda—that is, with the inestimable blessings of cheap glass and soap, cheap light and cleanliness, and a hundred collateral advantages—he was suffered, to the shame of Europe, to end his days in a hospital. There he lingered, a wreck in fortune, health, and hope, till reason herself gave way, and he perished madly by his own hand. It is to be hoped that with the advance of civilization these terrible tragedies, so frequent in past ages, will become more and more rare, till the future historians of progress shall be spared the pain and shame of recording any more such outrages on justice—such ghastly martyrdom of genius."

As the soda industry is the most gigantic chemical industry in its results upon the well-being of society, and the advancement of civilization, it is well to give a little history of it, as from its incipiency to its present state it belongs to the past hundred years, and, besides,

it is somewhat historic, too, in its relation upon the early recognition of the importance of the science of chemistry by great governments.

Early in the war of the French Revolution, France was cut off from her usual supply of soda, so requisite for many of its arts, as those of glass and soap-making, for at the time Spain supplied France with the soda she used, it being manufactured from the ashes of the sea-weed.

The French Convention at that time issued a proclamation, which went on to say: "Considering that the Republic ought to extend the energy of liberty to all of the objects which are useful in the arts of first necessity, free itself from all commercial dependence, and draw from its own sources all the materials deposited therein by nature, so as to render vain the efforts and the hatred of despots, and should place equally in requisition for the general service all industrial inventions and productions of the soil, it is commanded that all citizens who have commenced establishments, or who have obtained patents for the extraction of soda from common salt, shall make known to the Convention the locality of these establishments, the quantity of soda now supplied by them, the quantity they can hereafter supply, and the period at which the increased supply can be rendered."

In conjunction with the proclamation, a committee of four chemists was appointed in the first year of the French Republic to examine into all the processes devised for the purpose. The chemists were Lelievre, Pelletier, D'Arcet, and Giroud, and they made their report the following year, after having examined thirteen processes, six of these commencing with the formation of sulphate of soda from common salt; and here is what they say in their report:—

"Citizens Le Blanc, Dize, and Shee (copartners) were the first who submitted to us particulars of their processes; and this was done with a noble devotion to the public good. Their establishment had been formed some time previously at Trainciade, but the consequences of the French Revolution, and of the war which followed it, having deprived them of funds, the works were suspended, and for some months past the manufactory had become a national establishment.

"This establishment had been erected entirely with the private funds of the partners. It would be difficult to collect together, in so moderate a space, more means and conveniences than are met with in this manufactory—furnaces, mills, apparatus, and magazines, all arranged in the best order for the convenience of the service."

The report then gives a full description of all the various steps in the process that constitutes the invention of Le Blanc.

It is needless for me to detail how extended this soda industry has become, but will conclude this part of my subject by giving a chronology of the soda trade, as given by Gossage.

Chronology of the Soda Trade.

Period.	Raw material used, and prices.	Quantity manufactured.	Prices.
1790	Barrilla and kelp	Not known.	Not known.
1792	Le Blanc's process invented and applied in France	Not known.	Not known.
1814	Crystals of soda, made from Bleacher's residua, and by Mr. Losh from brine		Soda crystals $300 per ton.
1823 and 1824	Mr. Muspratt's works commenced using— Common salt at $ 4 per ton; Sulphur at 40 "; Lime at 4 "; Coal at 2 "	Probably 100 tons per w'k of crystals & soda ash.	Soda crystals $90 per ton, Soda ash $120 per ton.
1861	Fifty works in operation in Great Britain using Le Blanc's process. Raw material in Lancashire costing: Common salt $ 2 00 per ton; Sulphur from pyrites 20 00 "; Limestone 2 00 "; Fuel 1 50 "	5000 tons per week.	Soda crystals $22 per ton, Soda ash $40 per ton.
1861	Annual value of produce $10,000,000. Number of workmen employed in the manufactories 10,000, exclusive of those engaged in mining for pyrites, limestone, and coal; also those employed in navigation and other means of transport.		

The important bearing of the soda industry is the only excuse I have for so lengthy a reference to it, and I can only venture to touch upon two or three additional points in connection with it; the first is the recovery of the sulphur from what is known as the soda waste, thus making this agent to renew its function again and again in the production of soda. At present hundreds of tons of sulphur are recovered by processes well known to most chemists.

Another fact I must not omit is the employment of a large quantity of a mineral from Greenland called cryolite for the production of soda, and yet more recently the perfecting of what is known as the bicarbonate of ammonia process, by Salvay & Co., of Belgium, who in 1873 produced by this process 5000 tons of soda, employing 110 workmen.

Potash and its Salts.

Much of what has been said in relation to soda, is equally applicable to potash. This article, that was procured by the destruction of our forest, is now furnished in vast quantities and at a much lower rate from mineral resources.

The first one resorted to was the sea water, or rather the residual water after crystallizing out common salt for consumption in domestic economy and the arts. And one of the best methods of conducting the separation was devised by Balard, and is carried on to a considerable extent in France. But the great future source of potash is from the minerals sylvite, carnallite, kainite, and polyhalite, now discovered in great abundance in the salt mines of the Stassfurt, and other salt mines in the world.

The chemist converts the potash-chloride found in those minerals into the carbonate in the same manner as he makes the carbonate of soda from common salt.

Cyanide of Potassium.

This cheapening of potash of course gives new impetus to chemical industry dependent upon this alkali, among them the manufacture of cyanide of potassium, of which the most advanced chemistry is the manufacture of the cyanogen from its elements, although the practical application on a large scale still meets with considerable difficulty.

Oxalic Acid.

Another recent industry, sprung up from the application of potash in the caustic state, is the formation of oxalic acid by heating sawdust with it, there being usually employed with it a certain quantity of caustic soda, which latter alkali will not produce the required effect alone, although potash will, and the reason of the admixture with soda is to make the process more economical.

Soluble Silicates.

Cheap soda and potash have enabled the chemist to make on a commercial scale soluble glass. As an industry, it was started as early as 1825 by Fuchs, of Munich. But it has only been in latter years that its application has been extensive, and we are all now familiar with its use in hardening and preserving stone, preparing artificial stone, cement, etc.

Stearinery.

The next industry that demands our notice is that of stearinery and soap-making, and all that is important in connection with it belongs to the latter half of the past hundred years, and dates from the labors of Braconnot in 1817 in separating oleine and stearine, and were specially developed by the remarkable scientific researches of M. Chevreul.

That these labors deserve to be ranked so high, arises from the fact that they were made at the birth of organic chemistry, and on a most difficult class of bodies, about the nature of which there was no correct conception, and when the analysis of organic substances had been but just commenced. Still more, M. Chevreul did not give to the world the results of his labors as a mass of isolated facts, but he systematized and classified new acids, new bases, and left to us the chemical history of facts almost as fully made out as they are at the present time; and these have contributed as much, if not more than any class of researches to give direction and growth to organic chemistry. The decomposition of the fats and formation of the fatty acids developed the fact that, when melted and allowed to cool slowly, the more solid acids crystallized, so as to allow of easy separation of the solid from the liquid part, which fact soon suggested a practical application.

In 1823 a complete account of the labors of Chevreul was published; at this period fruitless efforts were made to manufacture stearic acid.

Importance of the Stearic Acid Industry.

It is difficult to render an exact account of the importance of the stearic acid industry; nevertheless it can be stated with certainty that the annual production for France is 50,000,000 of pounds, and approximately for the remainder of Europe is 200,000,000 pounds, and for America 20,000,000 pounds.

The largest candle factory in the world is that known as the Price Company, having its principal establishments at Liverpool and London, with a capital of $5,000,000. The great steps in the progress of this industry were first made by Gay-Lussac and Chevreul in 1825, who first thought of applying the fatty acids for illumination, forming them first by saponifying the fats by alkalies or the alkaline earths, decomposing by acid, and separating the solid and liquid acids by pressure.

It will be seen that this process is deduced directly from the theoretical researches of Chevreul, with the important exception in relation to saponifying under high pressure.

The process of Chevreul and Gay-Lussac was not considered at the time capable of being brought into practice in the arts from their using potash and soda, thus making the product a very expensive one.

Besides the above difficulty in the original development of stearic industry, another arose in the very commencement, viz., that when candles were made with the ordinary wick, they burnt very imperfectly, and the inventors above referred to devised wicks of peculiar description that answered the purpose more or less perfectly. But prior to them J. L. Cambaceres devised similar ones, and subsequently improved upon them, and finally settled upon the plaited wick now in common use in all stearic acid factories.

The next important step rendering the stearic acid industry a success, was also made by M. Cambaceres, viz., the separation of the oleic acid by powerful pressure, first on the mixed acids cold, and subsequently warmed; and he established a factory in Paris to carry out his process, but this soon failed, from the inferior nature of candle-stock produced, and the expense of its production, potash being employed by him as the agent for decomposing fats.

For several years this industry was abandoned, as being a difficult and unprofitable one, when in 1829, two young physicians, De Milly and Motard, took the subject up, and after two years of laborious and persistent study of it, accomplished the problem of the successful manufacture of candles from the fatty acids. It is only simple justice to say that the names of Chevreul and De Milly go side by side in this industry, and the first in his theoretical discoveries, and the latter in his ingenious and successful devices in the accomplishment of great practical results.

A second advance in this industry was the use of sulphuric acid to decompose the fats, which originated also with Chevreul and Gay-Lussac, but was not successfully carried out until combined with the distillation of the fatty acid after the decomposition—a method first executed by Dubrunfaut, and successfully carried out by Coley, Jones & Wilson, and subsequently perfected by Gwinne & Jones.

The next step made in stearinery was the decomposition of the fats by water. The conception of this method, in common with all the methods of saponification of fatty bodies, is to be referred back to the author of the discovery of the true nature of fats, M. Chevreul, for in his original researches he pointed out the perfect analogy between the fats and the compound ethers, the latter class of bodies being decomposed into their two constituents, in the presence of water heated in close vessels under pressure; a reasonable deduction from which was, that fats would undergo an analogous decomposition. This, however, was not undertaken at the time, but, by an accident about the time of Chevreul's researches, it was observed to take place by Faraday when his attention was drawn to some changes in oils used by Perkins in his curious steam engine that employed very hot water.

No attempt was then made to draw any practical results from these observations, and we find no further notice taken of the subject until early in the year 1854, by R. A. Tilghmann, of Philadelphia, when patents were taken out by him for decomposing fats mixed with water, and superheated in vessels of a certain description. The method of Tilghmann, as originally patented, was never introduced into practice; since then, with change in the manner of operating, and in the nature of the boiler, it has been successfully conducted in many factories.

In the latter part of the same year that Tilghmann's process was patented, M. Melsens, of Belgium, took out a patent very analogous, using fats mixed with water in the proportion of twenty to one hundred per cent. of the latter; the water might be acidulated with from one to ten per cent. of sulphuric acid, or the addition of salt would suffice; the whole was heated from 180° to 200° C., for several hours. The success of Melsens's process was immediate, and it was put into operation on a large scale in Antwerp, in vessels holding one ton of tallow, to which was added fifty per cent. of water, and in six hours the decomposition was complete at a temperature of 180° C. (ten atmospheres). The fatty acids thus made were of a very satisfactory quality, quite as much so as those obtained by other methods of saponification.

But I would here say that this method, by superheated water, is now supplanted by a mixed method of using one or two per cent. of lime with the superheated water, which addition facilitates and hastens the reaction in a manner not yet understood by chemists.

Glycerine.

This new art of stearinery assumed such dimensions, that the chemist sought to utilize all by-products connected with it. The oleic acid or red oil, as is well known, is used for various purposes, principally for forming soap.

The candle-makers at first allowed the glycerine produced, to run to waste. This sweet principle of the fat was first discovered by Scheele in 1873, and afterwards studied by Chevreul in 1819, and its true nature ascertained, as a triatomic alcohol of the radical glyceryle, now having a well-defined place in organic chemistry. But, like everything connected with the art of which we are speaking, some minds were directed to examining and purifying it, and when presented to the world abundantly in its pure form, some application was sought for it, and its use became extended day by day. The principal features connected with the improvement in its manufacture, relate to its distillation, and still later to its purification by crystallization by Sarg, and in 1871 he purified in this way twenty-five tons. As for its application it is more varied than that of any other substance springing from the chemical arts. It is used in wine-making, beer-making, confectionery, liquors, in cloth-making, in calico-making, in preparing leather so as to remain supple and durable, in the tobacco factory, for lubricating delicate machines and firearms, etc., preserving organic matter, filling gas meters to prevent the effect of cold, for making rollers for printing presses, in the art of perfumery, in medicines, etc.

Nitro-glycerine.

But of all the applications of glycerine, the most curious one is that of making an explosive compound for blasting rocks, etc., of which there are now not less than seventy or eighty tons consumed annually.

In 1847 an Italian chemist named Sobrero, working in the laboratory of Pelouze, discovered that the action of concentrated nitric acid or a mixture of nitric and sulphuric acid upon glycerine produced a peculiar oily liquid, having among other properties that of exploding when struck by a hard body, or when heated. At first it was only regarded as one of the many curious compounds that are born every day in the chemical laboratory. Any practical application was not thought of, for the glycerine then was too expensive a substance to enter into competition with other substances used in making explosive compounds. It was reserved for a Swedish chemist named Nobel to make an application of this oily compound called nitro-glycerine, and by improvement in the process of its manufacture, and the consequent impulse it gave to the separation and purification of glycerine, it is now a substance of every-day use by those engaged in mining and in large engineering works, requiring the removal of large bodies of rocks; and, notwithstanding it is an extremely dangerous substance to handle, and many lives and much property have been destroyed by it, contractors on large works say that they prefer using it to gunpowder, with all its attendant risks.

Gun-cotton.

Gun-cotton is another of those curious chemical triumphs of the past few years of chemistry. It was never imagined that this well-known and useful vegetable fibre called cotton, could be so easily converted into one of the most powerful explosive compounds known, and would serve as an article of offensive and defensive warfare. The first announcement of its dis-

covery was in 1845 by Prof. Schönbein, of Basle, and almost at the same time by Böttger, of Frankfort. Its powerful explosive nature was made very manifest early in the establishment of its industry, by two very disastrous explosions, one in 1847 in the gunpowder factory of Messrs. Hall Brothers, where they were making gun-cotton, and the other in July, 1848, where 3500 pounds of this substance exploded at Bouchet near Paris. These and other accidents so alarmed the public that its manufacture was suspended, especially as some of them appeared to arise from spontaneous decomposition of the gun-cotton. But as it is a part of the code of chemical ethics not to be frightened at anything, especially at a creature of its own creation, they went to work at once to discover causes and remedies, in which as usual they succeeded, so much so that at the present time a number of batteries of artillery in the Austrian service use gun-cotton. It is employed largely by the English government in their military service, under the efficient direction of Prof. Abel. It is also used for blasting in quarries.

The most recent development, however, in connection with it, is that it can be exploded efficiently when wet, by the aid of a fulminating fuse, which fact, if properly borne out by sufficient experience, will increase its value, in so far as it increases its safety of transportation, etc.

I must here refer to a curious property of gun-cotton, viz.: its solubility in ether, or a mixture of alcohol and ether, producing a solution called collodion, which is the menstruum used by photographers for placing the chemical materials on the surface of the glass to receive the action of the light in the preparation of what are known as negatives. It was first used for this purpose by an English photographer named Archer, although the collodion had been prepared some time before by Dr. Bigelow, of Boston, and used in the surgical treatment of wounded surfaces. The value of gun-cotton as a photographic agent cannot be overrated, when we remember the ramifications of this art in social life and scientific pursuits; in this latter direction it is especially valuable to the astronomer.

In strict justice I should class the art of photography as one of the chemical industries created during the past hundred years, for every step in its invention, application, and future development depends on chemistry; but we must be satisfied with a simple mention of it.

Chemical Industry of Coal.

I will not delay calling the attention of my audience to a chemical industry pre-eminently one of this century, and, curious enough, it does not owe its origin to either chemistry or to a chemist, yet in its developments some of the ablest chemical talent in the world has been and is still engaged. I allude to the chemical industry of coal.

It was started by two individuals of practical mind, Murdock in England and Le Bon in France, who sought to control the gaseous products emanating from burning coal in such manner as to be useful for illuminating purposes, and from the year 1800 to the present time it has been used successfully for that purpose, and all the large cities of Europe and America, and numerous small towns, give evidence every night of the universality of its use, dispensing comfort all around.

Its direct effect is to convert night into day, to make the short and obscure winter days equal to those of summer, giving more time to those occupied with indoor pursuits, and enabling them to conduct their labors with less fatigue to the eye and with more certainty of execution. In this aspect alone the immense wealth that has been added to the industrial arts is incalculable.

In its indirect effects, the use of coal-gas has benefited society by saving vast tracts of land for other agricultural purposes that would have to be devoted to the cultivation of plants furnishing oil and fatty matters, to be used for illumination, and, besides, there have been saved for other purposes hundreds of ships and thousands of seamen that would be required for the whale and other fisheries carried on simply for the purpose of procuring oily matter to be used for furnishing light.

Regarded as a luxury, its benefits are not to be despised, for it has cheapened many of them to such a degree that both rich and poor are equal participants of them. Our brilliantly lighted streets are evidence of this fact, so that the people traverse our cities with the same ease and security at night as in daytime. And here we may again allude to another fact in connection with the manufacture of coal-gas, namely, that the offensive residues which are the natural results of gas-making have been made to give rise to most important industrial pursuits, employing a large amount of capital and labor and accumulating much wealth.

But it has been left for the more recent developments of chemistry to extract from the residues of gas-making, by processes more or less indirect, beautiful crystallized compounds used in giving to silk, wool, and cotton colors that rival in brilliancy the hues of the rainbow; and this discovery in its turn reacts on the manufacturers of the various textile fabrics.

In the making of gas from coal three great residual products are formed, consisting of coke, ammoniacal liquor, and tar, the last two of which were cast away as refuse, but now, under the directing mind and skill of the chemist, they have been converted into most useful products, the ammonia being collected and condensed in such form as to be made serviceable for all purposes in the arts and agriculture, which latter industry now depends very much upon it in giving the requisite nitrogen elements to artificial manures.

But it is from the coal-tar that the chemists, during the past fifteen years, have reaped a harvest of wonderful chemical results; from it they have extracted not less than seven acids, fourteen alkaline substances, and ten neutral bodies, and with many of these they have wrought such wonderful metamorphoses that chemists themselves, accustomed though they be to strange transformations, are amazed at the results of their own investigations.

As much as we might desire, we have not time to dwell upon progressive discoveries that led to the first aniline color in 1856, by Hofmann and Perkins, and will only state that in the short period which has elapsed since then, the chemist does with the tar of gas-works what the rain drop does with white rays of the sun, viz., unfolds all the beautiful colors of the spectrum, red, orange, yellow, green, blue, indigo, and violet; first came the mauvine and rose aniline in 1856, then the aniline red in 1859, then the aniline blue in 1860, then the aniline green in 1863, after that the violets of methylic and ethylic rosaniline, and aniline black.

And now our beautiful dyes are no longer brought from the tropics and the Indies, but Europe sends to China, Japan, and the Indies dye-stuffs, and sends artisans to show to those nations how to apply those dyes; the moneyed value of the present product being about $10,000,000. Is this no triumph for the industrial chemistry of the nineteenth century? Nor have we arrived at the end of this matter of the chemical industry of coal. That most valuable substance, alizarine, the coloring principle of madder, had defied the chemist's skill to imitate and produce by artificial means. With the chemist, to accomplish it was only a matter of time, and about five years ago we had the first announcement of the production of alizarine from one of the coal-tar products (but little known and of no commercial value up to 1870). So rapidly has this branch of industry grown, that, during the last year there was put into commerce 1000 tons of artificial alizarine dye, with a standard of 10 per cent. of alizarine, worth upwards of four millions of dollars, one-half of which was produced in Germany. So that now the agriculturist engaged in madder cultivation is fearing the supplanting of madder altogether by this new chemical industry, which furnishes to-day nearly one-half the alizarine dyes.

Phosphorus and its Applications.

In phosphorus and its applications we have a chemistry of small things, but an industry of great magnitude. In the words of another, "Phosphorus is a singular instance of an article, discovered one or two centuries ago, which, until recently, possessed very little interest but to the professional chemist, and more rarely to the physician; but which, by an application dating back little more than thirty years, rapidly became an object of large manufacture, and is now, in the everywhere indispensable lucifer-match, carried not merely over the civilized world, but to every land which possesses any commercial intercourse.

"The Dutch chemists, who laboriously first drew it forth in minute quantities, and by a tedious process from urine, little thought that this substance, so distinguishable from its self-inflaming qualities, would, in after time, be manufactured by hundreds of tons, and be not only found in every household, but made the kindling spark of all hearths in every civilized country. One of the largest manufacturers of phosphorus, when he underwent training, only knew phosphorus by a small stick two inches long that was in the laboratory in which he studied. He now draws it out by machinery in a cord many miles in length, and sends it off by tons to all parts of the world." The improvements in the method of manufacture, and the amount of consumption, are best realized when you are told that upon the introduction of its use in the manufacture of lucifer-matches, its price in England was $20 per pound, while the price now does not exceed 75 cents to $1 per pound; this economy of production being brought about by improved chemical processes, and by operating upon cheap and accessible material. There now exists some twelve or fifteen large factories, one-half of them in Germany, from which most of the phosphorus used in this country is imported.

The quantity produced is not less than a half million of pounds, nearly the whole of which is consumed in the manufacture of matches, one-half the above quantity being consumed in Germany for that purpose. In the chemistry of phosphorus, the most remarkable triumph is that of Schrötter, about fifteen years ago, in producing what is called amorphous phosphorus, which is now well known to all chemists, and is used extensively in the art of match-making; this wonderful change in phosphorus being produced on a large scale, and its inflammability so altered as to allow of its being handled with impunity.

It is not volatile or subject to slow combustion, and does not poison the atmosphere in which the makers of matches are obliged to operate, and does not produce that peculiar and painful disease of the jaw, which ultimately produces caries of the bone, to such an extent, in some cases, as to necessitate the removal of a large proportion of the jaw; showing that the aim of chemistry is not only to increase and improve the materials for the use of society, but to present them in such form as not to injure the health.

Iodine and Bromine.

Of iodine and bromine I have but little to say, although both their discovery, and their chemical industry have been the growth of the past fifty or sixty years. This neglect does not arise from their lack of importance, for they both rank as articles of prime necessity in several of the most important arts, as well as important curative agents in disease. There has been much improvement in the art of extracting both iodine and bromine from their raw materials, and coal naphtha has become an important agent in facilitating the separation of the iodine, or rather in collecting the iodine once separated by chemical agency. Also the Peruvian nitre has now become an important source of this substance. As for bromine, its production is increasing every year both in this country and in Europe.

Sodium, Aluminium, and Magnesium.

While sodium, aluminium, and magnesium do not perform as yet very important functions in the arts, they are produced on no inconsiderable scale, and are conspicuous examples of how mere laboratory methods may be rapidly developed into industrial processes when di-

rected by the skill and ingenuity of able chemists. In this particular instance we are indebted to M. St. Clair Deville, than whom there is no more ingenious chemist in working out difficult problems in the metallurgy of the rarer metals.

The production of these metals in quantity has given new agents to the arts, and sodium amalgam is now well known in metallurgic operations on gold. Aluminium and aluminium bronze have found their use for many valuable purposes, and magnesium is much valued for signal and rocket purposes.

Medicines.

But of all the benefits derived from the growth of mere laboratory processes into grand manufactural operations, none can claim more than the art of medicine, for she has received her full share, as we all well know, and as is every day shown by the operation upon cargoes of Peruvian bark to extract that valuable medicine quinine, and the elimination of thousands of pounds of morphine from opium; and, still more recently, the unfolding of the hidden treasures of the chemist has brought to light chloroform and chloral, the earlier specimens of which he valued as gold or silver, while now they are thrown upon commerce by thousands of pounds, alleviating an untold amount of suffering; and these great blessings are afforded mankind as a free-will offering of the skill and industry of the chemist, for he invokes no patent laws to make money from these precious gifts of God, whose high priest he is in one sense, having been favored by the divine dispenser of all good to make known these things to man.

The review just given of the chemical industry of the past hundred years, is but a notice of the salient points in connection with its history and progress. No mention is made of the art in connection with the working of iron, copper, and other metals, for that now takes rank almost as an independent art, called metallurgy, but it is none the less chemical in its character, and, as chemistry progresses, so will this art. The same may be said in regard to glass-making, photography, electrotyping and gilding, and numerous other arts which must have presented themselves to your minds during this discourse.

But I must not detain you longer, and shall conclude by congratulating you that we are living in an age in which an industry requires but a few years for its creation or development.

"In our days a useful discovery is scarcely made, or a happy application of one found out, before it is published, described in the scientific journals, or other technical periodicals, and especially in the specifications of patents. It then becomes the starting-point of a thousand researches and new experiments, entered into by the philosopher in the hope of advancing scientific progress, and by the manufacturer with the expectation of reaping a material benefit. From these multiplied and diverse efforts—these incessant labors of an army of workers—arises an industry which has no sooner sprung into existence than it becomes important and prosperous."

So then let us, American chemists, bend all our energies to do full share of this work. Up to the present epoch our short existence as a nation, and some other causes, have forced us to be the recipients of the numerous discoveries of our European co-laborers without an adequate return on our part; but there will be no such excuse for the future if we do not stand side by side with them in the developments of industrial chemistry.

AMERICAN CONTRIBUTIONS TO CHEMISTRY.*

BY BENJAMIN SILLIMAN,

Of Yale College.

ADDRESS.

Introduction.—The history of modern chemistry, commencing with Priestley's immortal discovery of oxygen, or dephlogisticated air as he called it, on the 1st of August, 1774, by a memorable coincidence is almost identical in date with the evolution of the United States of America out of their colonial pupilage by the declaration of their independence of the mother country. The emancipation of our science from the dominion of phlogiston, with its seductive but false philosophy, may be likened to the overthrow of aristocratic traditions, and monarchical supremacy, under which our ancestors were held, and the building up of the American system of self-government in their place. We note with satisfaction that the scientific revolution was a little in advance of the political revolution; and it would not be a difficult task to show, were it pertinent to our present purpose to do so, how closely and logically the rapid march of human society, the world over, during the century whose close we celebrate to-day, has kept pace with and waited upon the advance of the pioneers of scientific discovery. How Franklin and Black, Rumford and Cavendish, Priestley and Lavoisier, Galvani and Volta, Scheele and Berzelius, Dalton and Davy, Ampère and Faraday, Hare and Henry, Oersted and the Herschels, Liebig, Agassiz, and a multitude more of the noble army of martyrs to science, who have devoted their lives to the search for truth for the truth's sake, have, by the discovery and elucidation of principles before unknown or but dimly discerned, opened the way for the yet greater army of inventors and projectors, who have followed in their lead; with steam engines, railways, steamships, mechanical spinning and weaving, voltaic casting of metals, bleaching and other chemical arts without number, electric telegraphs, illumination by gas, photography, improved agriculture, artificial heat and artificial cold; using and applying in endless forms for human advancement, the public wealth, and private enjoyment the labors of those who have toiled to reveal the hidden truths of God in nature, too often unrequited for their self-sacrificing devotion in the good things of this world, but content to work that others might enter into their labors.

* In attempting to comply with the invitation of the committee in charge of the Chemical Centennial at Northumberland, to prepare an "Essay upon American Contributions to Chemistry" as an address to be delivered on that occasion, I found the "Essay" insensibly and almost unavoidably assuming the historical form, and taking a wider range than may seem consistent with a strict rendering of its title. But such as it became it is now presented as a slight contribution toward a more elaborate historical discourse which yet remains to be prepared. B. S.

Among the greatest discoveries of modern times, comparable to the discovery of the law of gravitation itself in the previous century, was the discovery of oxygen by Priestley, August 1, 1774, which we are here to honor this day. What Newton's discovery did for celestial mechanics, in bringing order out of confusion, and co-ordinating things before beyond our reach, has Priestley's discovery done for the former chaotic confusion of facts in chemistry inherited from alchemy and the iatro-chemists, but impotent to explain the constitution of the universe of matter, for the want of the philosophy to which a knowledge of oxygen was the key.

In attempting to review the contributions to our science at the hands of American investigators during the century we celebrate to-day, it is proper in bar of criticism to say that I was called at a very late hour to the task in hand, and have become more sensible as the work opened before me of the disproportion between the brief time at command and the extent of the task assigned me. If important omissions are detected—and that there are such can hardly be doubted—the speaker must beg of his fellow workers in the common field some indulgence, as is due to human frailty; and while he is conscious of a desire to do full justice to the labors of all, he has also the knowledge that all among living laborers have not responded to his call for co-operation.

If an apparently undue proportion of space has been given to some portions of the historical part of our essay, it may be said in fairness that it is far easier and more just to write history than to anticipate it, and we who live in this latter end of the first century of modern chemistry must see to it that we leave such footprints in the sands of our time, that the future historian of the science cannot fail to do us justice.

In considering the contributions to chemistry made in the United States, the subject naturally divides itself under two subdivisions—the historical and the contemporaneous contributions.

Under the first division we may consider very briefly the scientific societies, public seminaries of learning, and channels of communication which were open to the investigators and students of science during the latter part of the last and the commencement of the present century. In doing this it will be convenient and in order to consider to some extent the work done in those times of which records exist. If some of it seems to us not very important, we must remember that such was then the case the world over, with a few brilliant exceptions, and of such exceptions I think it will appear that we have our full share.

Learned Societies.—Of societies devoted to scientific purposes, and which have left us any published memoirs or transactions, we find very few prior to the close of the last century.

In New England there was "The American Academy of Arts and Sciences," at Boston, instituted in 1780. "The Connecticut Academy of Arts and Sciences," established at New Haven in 1799, and, oldest of all, we find in Philadelphia "The American Philosophical Society," established by Benjamin Franklin in 1743, and recognized by provincial charter in 1769. This completes the brief list of learned societies instituted prior to the close of the last century which have published anything. The Literary and Philosophical Society of New York, which published a single volume in the early part of this century, had but a brief existence, and its volume of memoirs contains only one paper on chemistry.

Some of the Men Prominent in Early Scientific History in the United States.—In the history of science during the latter half of the last century we find prominent the names of Franklin, Rumford, and Priestley; the first two Americans by birth and education, the latter by sympathy and adoption. In the evening of his peaceful and philosophic life Priestley was a refugee from a strange intolerance and persecution which has left a stain upon the good name of England.

FRANKLIN was the founder of the American Philosophical Society in 1743, the oldest of all the scientific societies of America; he was also the originator of the University of Pennsylvania, and of the Public Library in Philadelphia. He was the president of the Philosophical Society after its charter in 1769 until his death in 1790. His own scientific researches were chiefly physical, and his labors as an investigator had mainly ceased prior to the dawn of our chemical century. But his tastes and well-grounded love of all knowledge and of all investigation into the laws of nature, made him to the last a devoted student and the zealous patron of all departments of science. He died just before Priestley's arrival in America, but in London, many years before, they had been associated in electrical investigations, and Priestley's History of Electricity was undertaken by the advice of Franklin, to whom the manuscript was submitted for criticism.

RUMFORD, whose scientific reputation is sure to grow with the passage of time, as it has done indeed constantly since his death, after imbibing from Dr. Williams, his instructor, a love for mathematics and the exact sciences, while yet a boy; and from the lectures of Dr. Winthrop, at Harvard, his early love for physical and chemical research was, by the force of circumstances over which he had no control, in a sense expatriated and forced into a position of disloyalty to the Republican cause. His life reads like a romance. We find him, after a term of service as a British officer, passing into the position of confidential adviser of the King of Bavaria, and in full charge of matters military, administrative, and philanthropic, with a field of usefulness and a rôle of honor seldom awarded to a humble born citizen of a foreign land. Yet amid all his great official cares and preoccupations, and his honors, social, military, and political, he was ever loyal to scientific research; embracing every occasion to glean new facts in the experience of daily life even when most oppressed with heavy public duties. This is everywhere evident in his memoirs. Thus, in the opening paragraph of the memoir which is undoubtedly on the whole his most important contribution to molecular physics, the research which first established on experimental grounds the relations of heat to motion,* he says, in his opening address to the Royal Society, in whose Transactions this remarkable paper first appeared: "It frequently happens that in the ordinary affairs and occupations of life, opportunities present themselves of contemplating some of the most curious operations of nature. * * * I have frequently made this observation, and am persuaded that a habit of keeping the eyes open to everything that is going on in the ordinary business of life has often led, as it were by accident in the playful excursions of the imagination, put into action by contemplating the most common appearances, to useful doubts and sensible schemes for investigation and improvement, than all the more intense meditations of philosophers in the hours expressly set apart for study."

* An Enquiry Concerning the Source of Heat which is Excited by Friction. Complete works, I. p. 471. Am. Academy edition.

We claim Rumford as an American, and we look with the greatest satisfaction upon his scientific career and upon the character of his work, which in its method and expression is a model of elegance which will ever render his writings a classic in the literature of science. Let any young student who wishes to learn how physical and chemical truths are evolved by inductive research take up the study of almost any one of Rumford's memoirs—for example, that upon "the propagation of heat in fluids," in which, among other important data, the maximum density of water was first determined and the law of its unequal movements under equal variations of temperature first fixed by experiment—and he will find with what largeness of grasp and accuracy of detail the mind of this master marches upon the area of the unknown to take captive the facts of observation and marshal them in order to science. No writer of his time has left a nobler record of original power in physical science than Rumford. None in his time and for succeeding times has done more, and so well, to solve some of the toughest problems of social science than he.

Joseph Priestley's name is immortal in the annals of our century of chemistry. We are proud to claim him as an American by adoption, and are quite willing to adopt with him all his discoveries. A distinguished French Academician of this century once said, on presenting for the first time to the Academy of Sciences in Paris a memoir on the Law of Ohm, respecting electric conduction (long before accepted and familiar in Germany, but then first made known in France), "Truly, Mr. President, this is not a French discovery, but it is worthy to be made such!" So say we of Priestley and the discovery of oxygen: if it was not an American discovery, it is worthy to be made such. Whom England cast out with obloquy, we accepted with cordial hospitality. His heinous sins of republican ideas and hostility to an established church became virtues here, while his pure and blameless life, devoted during his later years, as in all his earlier career, to the cause of humanity and all truth, is his best defence against the charge of heresy which served as one poor factor in the indictment under which his house was destroyed by a mob, his apparatus, manuscripts, and library, the fruits of diligent years of research, consumed and scattered in the disgraceful riot at Birmingham in 1791, while he and his family fled for life to safer retreats. It is not part of my duty, agreeable as it might otherwise be, to draw the life and memorialize the scientific discoveries of Priestley. On this occasion that pleasing task falls to other and abler hands.

After his removal to the United States Dr. Priestley, re-established in the philosophic repose of his delightful home, here on the banks of the Susquehanna, again resumed his scientific studies. Here he completed his discovery of carbonous oxide, and here he composed his later papers which are recorded in the early volumes of the American Philosophical Society's Transactions; and in Dr. Mitchill's Medical Repository. These contributions were largely devoted to sustaining the phlogistic theory, of which he remained to the last an ardent defender, notwithstanding his own researches, and especially the discovery of oxygen, had supplied the weapons with which the antiphlogistians triumphed. There are few more remarkable examples than his in the range of philosophy, of the power of a grand idea to maintain itself against the inevitable logic of facts—of the subtle power of a plausible but untenable hypothesis to lead captive the imagination and pervert the reasoning powers. Even the absurdity of taking refuge behind an assumed principle of *specific levity*, to which the disciples of Stahl were driven to avoid the unquestionable testimony of experiment, seemed not to stagger the faith of Priestley, who has shown himself the master of a powerful logic when dealing in the polemics of statesmanship and the church. But while we may wonder almost if the defender of phlogiston at Northumberland can be the same man who is the author of some of the most remarkable researches in chemistry in his time, we cannot but admire the charming spirit in which he conducted his controversies with Woodhouse, Green, McNevin, and Dr. Mitchill, a controversy which, begun as strangers personally, led to a warm and lasting friendship, especially with the latter chemist.

In his paper, read December 20, 1799, before the Philosophical Society at Philadelphia, entitled "Experiments on the change of place in different forms of air through several interposing substances," he recognizes distinctly, for the first time, the phenomena of gaseous diffusion, and demonstrates the facts by original and ingenious experiments. He did not, however, carry the research far enough to reach the *law* governing the phenomena, a generalization reserved for Graham in our time.

We have quoted from one of Prof. Dove's lectures the anecdote illustrating the spirit of the French Academician in his willingness to gallicize a German discovery. We all remember the recent controversy excited by the opening sentence in Ad. Wurtz's *Discours Préliminaire* prefixed to his Dictionary of Chemistry (1868): "*La chimie est une science française.*" While with certain qualifications it is true that modern chemistry has its starting-point with Lavoisier and his colleagues, still we cannot fail to recognize in this sweeping declaration the same spirit of appropriation, nor wonder at the animosity it excited in Kolbe and other German and English writers.

Early Scientific Foundations.—Of foundations for exclusively scientific purposes made in the latter part of the last century, we enumerate but four:—

1. That of Rumford to the American Academy in Boston.

2. The foundation of the Rumford Professorship out of the residue of Rumford's estate at Cambridge.

3. The Magellan foundation, given to the American Philosophical Society in Philadelphia.

4. The Erving Chemical Foundation at Cambridge.

In the year 1796, Benjamin Thompson, Count Rumford, made to the American Academy, at Boston, a donation of five thousand dollars three per cent. stock in the funds of the United States, the income of which was for the award of two medals every second year for original researches and a published memoir in any part of America, upon heat and light. (*Memoirs Am. Acad.*, II., 141, 1804.)

The history of this foundation is recorded in Dr. Ellis's charming Memoir of Rumford, lately published by the American Academy, pp. 250–268. It appears that the Academy, in discharge of its trust, caused, in 1799, advertisements to be published in all the principal cities of the United States, giving notice that they were prepared to award this honorable distinction to any worthy claimant who might be entitled to receive it. But it was not until the year 1839 that an occasion was found which was deemed by the Academy worthy of this honor; and it must ever be a source of just pride to the chemists of America, that in the year mentioned the Academy gave from the interest of the Rumford fund

the sum of six hundred dollars to Dr. Robert Hare, of Philadelphia, in consideration of his invention of the compound blowpipe, and his improvements in the voltaic pile.

It may seem to some rather surprising that the Academy did not make the award to Rumford himself, in his lifetime, for his various discoveries respecting light and heat. They were probably restrained from doing so by a scrupulous regard for the literal terms of the trust; seeing, while Rumford was an American, he was not, during the time of his principal researches, resident in "any part of the continent of America."

This consideration need not restrain us, however, from doing honor to the American who demonstrated that heat was a mode of motion, more than a generation before the time of the modern philosophers to whom this discovery is often awarded.

In 1870 the Rumford Medal Fund had accumulated to upwards of thirty-seven thousand dollars, and by a decree of the Supreme Court, made under authority of the Massachusetts Legislature, the Academy was authorized to award Rumford medals annually; to add to such award a pecuniary grant for scientific work, not more than three hundred dollars in any one year, and to expend such further sums as in their discretion may seem best calculated to facilitate the making of discoveries and improvements which may merit the premiums to be by them awarded, etc. (*Life of Rumford*, p. 266.)

The "Life of Rumford" and "The Complete Works of Rumford," published by the American Academy of Arts and Sciences, now in progress, will probably fill five or six 8vo. volumes, of which Dr. Ellis's Life of Rumford is one. This and three volumes of the "Complete Works" are already published by the Academy. No American, since "Franklin's Life and Works" were printed, has received a more enduring scientific commemoration than this.

The Erving Foundation of £1000, in 1791, for the endowment of the chemical chair in Harvard University, was, I believe, the earliest foundation of its kind in America. It is further noticed under the name of Aaron Dexter.

The Rumford Professorship at Harvard was, by the will of Rumford, declared to be founded "to teach by regular courses of academical and public lectures, accompanied by proper experiments, the utility of the physical and mathematical sciences, for the improvement of the useful arts, and for the extension of the industry, prosperity, happiness, and well-being of society." The "Rumford Fund" for this professorship amounted, in the books of the college treasurer in 1870, to $52,848. On this foundation, there have been four appointments, viz.:—

Dr. Jacob Bigelow,	from	1816 to 1827.
Prof. Daniel Treadwell,	"	1834 to 1845.
Prof. Eben N. Horsford,	"	1847 to 1863.
D. Wolcott Gibbs,	"	1863 to 1874.

While chemistry was not a subject specified in the will of Rumford, it was so plainly congenial to his purposes, that the Rumford professor was in charge of the chemical work of the Lawrence Scientific School from 1847 until, quite recently, its incumbent, under the new *regime* at Harvard, has been remanded to the specific work of the foundation, and the chemical work has been placed under the direction of the Erving chemical chair.

The Rumford foundation has contributed to our American scientific literature, aside from the separate memoirs of its distinguished incumbents, some of which will have our attention hereafter among our chemical contributions, a volume entitled "Elements of Technology" (Boston, 1829), containing the lectures of Dr. Bigelow, delivered during his ten years of service on that foundation.

The Magellan Fund.—In January, 1786, Mr. J. H. de Magellan, of London (not to be confounded with the navigator Magalhaens, b. 1474, d. 1521, and after whom the Magellan Straits are named), gave to the American Philosophical Society the sum of two hundred guineas, to be vested in a permanent fund, the income of which was to awarded in medals of gold, with a specific inscription, in reward for original observations "in navigation or natural philosophy, mere natural history alone excepted." I have not found any award of this medal for researches in chemistry.

These are all the foundations of which I have observed any notice, for the encouragement of chemical and physical research, prior to the close of the eighteenth century, in this country.

Chemistry in America prior to the Commencement of the present Century.—Of public seminaries of learning, other than medical institutions, where chemistry was taught from a separate chair, and as a distinct branch of the college curriculum of instruction, prior to A. D. 1800, we find but one, and this distinction belongs to Nassau Hall, in Princeton, N. J. On the 1st of October, 1795, the day after the annual commencement in that year, the trustees of that institution elected Dr. John Maclean Professor of Chemistry. He was a young chemist of Scotland, fresh from the instruction of Black and Hope and of the French School. But it is only just to add that Dr. Maclean, on the death of his colleague in the Chair of Mathematics and Natural Philosophy, assumed these duties in addition to those of chemistry. Dr. Maclean ever deserves honorable mention as one of the earliest and most successful teachers of our science in this country. Prof. Silliman in his reminiscences gratefully recognizes his obligations to Dr. Maclean and to Princeton. He says (vol. 1, p. 100, Fisher's Life), "I regard him as my earliest master in chemistry, and Princeton as my first starting-point in that pursuit." Dr. Maclean in 1812 accepted the chemical chair in William and Mary College in Virginia. In Paris Dr. Maclean had learned to admire the antiphlogistic theory, as the "new chemistry" of Lavoisier was then called, and which he taught and defended at Princeton.

In 1797 he published "Two Lectures on Combustion, supplementary to a Course of Lectures on Chemistry; read at Nassau Hall, containing an examination of Dr. Priestley's considerations on the Doctrine of Phlogiston and the Decomposition of Water." These lectures display both ability and learning, and form an interesting chapter in the history of the phlogistic discussion.

Dr. Maclean contributed several articles to the *N. Y. Medical Repository*, and his name is associated with that of Prof. Silliman in editing the first American edition of Henry's Chemistry in 1808.

Lectures on chemistry were given in connection with the Chairs of Physics or Natural Philosophy, and in the medical departments of several colleges at an earlier date than at Princeton.

At William and Mary the Right Rev. James Madison was Professor of Chemistry and Natural Philosophy as early as 1774.

At the University of Pennsylvania we find Dr. John

Ewing filling the Chair of Natural Philosophy and Chemistry from 1779 to 1801.

At Yale a chemical chair was instituted in 1798, but no professor was appointed until 1803.

At Columbia it was resolved in 1800 that chemical instruction should be separately given as a condition for the bachelor's degree, but no professor was appointed until 1802.

In the other academic colleges we find that chemical instruction was commenced at Bowdoin in 1805 by Parker Cleaveland, who held the office to 1858; in South Carolina College in 1811; in Dickinson College in 1811, and at Brown University in the same year; at Dartmouth in 1820; in Rutgers in 1830, and in Williams in 1830.

In the medical colleges we find chemistry early recognized as a branch of the curriculum of medical study, but at first in connection with materia medica. Thus in—

The University of Pennsylvania in	1768.
King's (Columbia) College	" 1767.
Harvard College, Mass.,	" 1782.
Dartmouth College, N H.,	" 1798.
College of Medicine, Md.,	" 1808.

What kind of chemistry it was which was taught prior to the discovery of oxygen, it is easy to understand, and yet we must not suffer ourselves to undervalue the knowledge of those days. But of one thing we may be sure—we shall find little to detain us in examining the contributions to chemistry made in those early times. A few names of chemists stand out in bold relief on that distant background, but we find on examining the record that they shine rather by the brightness of their performances in other departments of knowledge than in chemistry. This is true of that eminent man, Dr. John Winthrop of Harvard, already named. Of the chemical work of his successors, Williams and Webber, if they did any, we have no record, and the same is true of Aaron Dexter, Prof. of Chemistry and Materia Medica at Cambridge from 1783 to 1806. But of the eminent abilities of John Gorham, who succeeded Dexter, we shall speak among the men of this century.

So in Philadelphia we find that eminent man, Dr. Benjamin Rush, elected to the chemical chair in the University of Pennsylvania, August 1, 1769, but we discover no record of his chemical work. He had been a student at Edinburgh, under the instruction of Dr. Joseph Black, and was an able expositor of the doctrines taught by the renowned Scotch teacher to whom belongs the honor of inaugurating the quantitative methods in chemistry, first set forth in his research into the difference between the so-called mild and caustic alkalies, in his well-known essay "De Magnesia Alba," in which he distinctly recognizes the function of carbonic acid, under the name of "fixed air." Dr. Rush was undoubtedly the first professor of chemistry in America, and as such his name must ever be entertained with respect, while he owes his well-earned reputation to his labors in other departments.

Dr. James Hutchinson, who succeeded Dr. Rush, had finished his studies in London, under the renowned Dr. John Fothergill, and that he had attained notable proficiency in the science of chemistry we must believe, from the fact that in the year 1774, the trustees of the Philadelphia College presented him with a gold medal "for his superior knowledge in chemistry," inscribed "Jacobus Hutchinson, 1774," and on the reverse, "Naturæ Artisque Arcana Retexi." After his death in 1793, the chair of chemistry was filled by the appointment of Dr. James Woodhouse, of whom more particular mention is made below.

I have been unable to find any original contributions by Dr. Hutchinson to our science. He lived amid the troubles of the American Revolution, and took an active part in the direction and organization of the medical department of the army under Washington, as well as in the local politics of Pennsylvania.

James Woodhouse was the Professor of Chemistry in the medical department of the University of Pennsylvania from 1795 to his death in 1809, succeeding Dr. Hutchinson; Dr. Priestley having declined the chair, to which he had been unanimously elected. Dr. Woodhouse was a frequent contributor to the *Medical Repository* of Dr. Mitchill, the *Medical Museum* of Dr. Coxe, and the American Philosophical Society, but his original investigations were few. His paper in answer to Dr. Priestley's arguments on the doctrine of phlogiston, which will be found in the *Am. Phil. Trans.* for 1794, p. 452, was sustained by well-devised experiments. He also, while in England in 1802, communicated to *Nicholson's Journal* (vol. ii.), "Experiments and observations on the vegetation of plants, to show that the common opinion of the amelioration of the atmosphere by vegetation in solar light is ill-founded." This paper was reproduced in the *Ann. de Ch. et Phys.*, xliii. 1802, p. 194, and in the same journal he published "An account of an experiment in which potash calcined with charcoal took fire on the addition of water, and ammoniacal gas was produced" (*Nicholson's Journal*, xxi. 1808. pp. 290, 291). He was, I think, the first to demonstrate, by several comparative experiments, "the superiority of the anthracite coal from the River Lehigh, in Northampton County, Pennsylvania, over the bituminous coals of Virginia, for intensity and regularity of heating power," an interesting historical fact.

Dr. Woodhouse in 1807 edited an edition of *Chaptal's Elements of Chemistry*, in two volumes, with many notes and additions, besides editing an edition of *Parkinson's Chemical Pocket Book*, 1802, with an appendix containing the principal objections to the phlogistic theory of chemistry, and a plate of his working laboratory. Professor Silliman attended the lectures of Dr. Woodhouse in 1802–3, and has drawn his portrait in his personal reminiscences. (See *Life of Silliman*, by Fisher, 1865, i. 100.)

Aaron Dexter, Professor of Chemistry and Materia Medica at Harvard College for thirty-eight years, from 1783 to 1816, was neither a man of research nor a successful teacher, if we may trust the memories of some of his pupils, who still survive, but we owe him thanks in that his influence (says Quincy, in his History of Harvard University) probably availed to induce Major William Erving to endow the chemical chair in Harvard College by a bequest of one thousand pounds in 1791, which chair has since been called after the founder.

In New York, where the learned Dr. Samuel Bard early instituted a medical school, which was united with King's (now Columbia) College, and which conferred its first medical degrees in 1769, we find but little to require our notice in chemistry prior to the appointment of Dr. Samuel Latham Mitchill, who was elected in 1792 "Professor of Chemistry and Natural History," in Columbia College. Few names in the early annals of American science are more worthy of our respectful regard than that of Dr. Mitchill. He was the first pro-

fessor of chemistry in the United States who introduced a knowledge of the Lavoisierian nomenclature, preceding Dr. Maclean in this by two years. Very soon after his appointment we find him in 1794 publishing an essay on the "Nomenclature of the New Chemistry," and involved in a friendly controversy with Dr. Priestley on phlogiston, to which allusion has already been made. In 1797 he published in *Nicholson's Journal* (i. 481–487) "An attempt to accommodate the disputes among the chemists concerning phlogiston." Dr. Mitchill was a man of wide grasp and varied learning, keenly alive to the importance of all knowledge, and an earnest worker in many lines of research. He established in 1798 the *New York Medical Repository*, etc., the first journal which was devoted to general as well as medical science in the United States. In 1796 he made "A mineralogical exploration of the banks of the Hudson River," which was the earliest attempt in America in this line of research, and in 1804 he published in the *New York Medical Reporter* "A sketch of the mineralogical history of the State of New York." In 1809 he also published in *Tilloch's Magazine* (xxxiv. 125) a "Discourse on Mineralogy." Of chemical papers he published, besides many minor notices in his own journal, in *Tilloch's Magazine*, in 1800, "On the non-action of nitric acid on silver, copper, and tin" (vii. pp. 83–85), and again in *Tilloch* (xx. 1800, 97), he communicates "Some interesting particulars on the history of the muriate of soda." In 1802 he presented a memoir to the American Philosophical Society, entitled "Observations on soda, magnesia, and lime, in the water of the ocean, and how the water of the ocean may be rendered fit for washing without the aid of soap." (*Trans.*, v. pp. 139–147.) In 1801 Dr. Mitchill published his "Synopsis of Chemical Nomenclature and Arrangement."

While Dr. Mitchell's chief contributions to science were in zoölogy and general science, we see by this sketch that he was one of the earliest contributors to our chemical literature, and the first author in the United States, whose name appears in the list of writers upon chemical philosophy.

Of journals and periodicals devoted to science in the last and the early part of the present century, there were very few or none, aside from the Transactions before referred to, in which science, properly so called, found any recognition, and such as there were were generally medical journals prior to the end of the last century.

The Medical Repository, conducted by Dr. Samuel L. Mitchill and others, in New York, commenced in 1798, and was continued with various editorial changes until 1824. It was the vehicle for a number of chemical contributions, and especially did Dr. Joseph Priestley near the close of his life publish in it several letters devoted chiefly to the defence of the phlogistic theory. It counted among its contributors also Dr. James Woodhouse, who was the antagonist of Dr. Priestley in the phlogistic controversy, Dr. McNevin, Dr. Griscom, and others.

The Philadelphia Medical Journal was the resort of Dr. Robert Hare, as well as of the authors before named; Coxe's "Medical Museum," in Philadelphia, the Baltimore Medical Journal, the New York Medical and Physical Journal, by Dr. Hosack and others; and the Boston Journal of Philosophy and the Arts need not detain us, as their objects were mainly medical, and chemistry was only incidental to them.

The chemical student of to-day will find little to reward him in his search in these border lands of our science.

In January, 1810, appeared in New York the first number of *The American Mineralogical Journal*, conducted by Dr. Archibald Bruce, Professor of Materia Medica and Mineralogy, etc. This was the first journal entirely devoted to science, and supported exclusively by original American contributions, which appeared in the United States. It ceased with the appearance of its fourth number in 1814, and in all covers only 270 pages. It received the support of many of the working men of the times in its own departments, and contains the original record of many interesting observations in both mineralogy and chemistry, to some of which more particular reference will be made.

In 1817 appeared the first volume of the *Journal of the Academy of Natural Sciences of Philadelphia*, aided by the well sustained liberality of William Maclure, a name never to be forgotten in the history of American science. This journal, although essentially devoted to natural history, was also the vehicle for some early chemical contributions. We find among its contributors the names of Keating, Vanuxem, Morton, Troost, Bowen, H. Seybert, and others of the older chemists and mineralogists.

In July, 1818, appeared the first number of the *American Journal of Science*, conducted by Benjamin Silliman, of Yale College. A perusal of the "Introductory Remarks" by the editor at the opening of the first number, reveals the spirit in which this undertaking was commenced. After paying a deserved tribute of respect and affection to Dr. Archibald Bruce, whose death had just then put an end to his journal, Prof. Silliman remarks: "Most of the periodical works of our country have been short-lived. *This* also *may* perish in its infancy; and if any degree of confidence is cherished that it will attain a maturer age, it is derived from the obvious and intrinsic importance of its undertaking; from its being built upon permanent and momentous national interests; and from the evidence of a decided approbation of the design on the part of men of the first experience, obtained in the progress of an extensive correspondence." The founder lived to see the completion of the first series of fifty volumes, and thirty-eight volumes of the second series in 1864, which closed the first century of volumes in 1870. This journal belongs, then, to both the historical and contemporaneous divisions of our subject, and in its successive indexes will be found the titles and authors of the larger number of the most important American contributions to chemistry.

It is not requisite to our purpose now to consume valuable time in enumerating the titles of the various journals, proceedings, and transactions which have appeared in constantly increasing numbers since 1818. They are familiar to all students of science, and few of them are specially devoted to chemistry. We should not fail, however, to name—

The Franklin Journal (now the *Journal of the Franklin Institute*), commenced by Dr. Thomas Jones, of Philadelphia, in January, 1826, under the auspices and as the organ of the Franklin Institute of Philadelphia. It has been continued monthly ever since, under various editorial changes, and has now just completed the sixty-eighth volume of its third series, which has lately passed under the editorship of Prof. George F. Barker, of the University of Pennsylvania, making, with thirty volumes in the first two series, ninety-eight volumes in all. This journal, although avowedly and

largely mechanical, has always been, to some degree, and especially of late years, a vehicle for original communications in physics and chemistry. Its life commenced with the opening of the semi-centennial of the century we celebrate.

The American Chemist, New York, is a monthly journal devoted exclusively to chemical subjects, under the editorship of Professors Chas. F. Chandler and Wm. H. Chandler. It was commenced in 1870, and has concentrated and called out an amount of original work and authorship in chemistry, which is the best evidence of the large number of working chemists now engaged in our science in the United States. In its pages appear, as in no other American journal, the full record of such occasions as this which we now celebrate, with full abstracts of foreign chemical papers in all languages.

Of the *Boston Journal of Chemistry*, and other more purely special or technical journals, of which each department of chemical art now counts one or more, we can speak only in the most general terms. Among these, however, we should by no means pass without special mention the *American Journal of Pharmacy*, which, from its commencement in 1825 to the present time, has been the repository of all that is most valuable in this branch of chemistry. In it are recorded the labors of Daniel B. Smith, R. E. Griffith, Geo. B. Wood, Bache, Carson, Hodgson, Durand, Parrish, Bridges, Bullock, Maisch, Mayer, and above all of W. Procter, Jr., whose untimely death still leaves him with a record the bare enumeration of which fills seven closely printed columns, comprising the titles of over six hundred articles, of which a large number are original. A general index to forty-two volumes of this journal was compiled in 1873, by H. M. Wilder—8vo. pp. 314. Philadelphia.

Transactions of Learned Societies.—In these we find the only record often of the early work of American chemists, and we will next consider some of the more important of these.

"*The American Academy of Arts and Sciences*," at Boston, was established by a charter of incorporation granted May 4th, 1780, and its first volume of *Memoirs*, to the end of 1783, appeared in 1785, in 568 pages, 4to. Of the fifty-four memoirs printed in this volume, the most numerous and important are the astronomical and mathematical papers, among which we cannot notice without interest at this time the observation of the transit of Mercury over the sun November 12th, 1782, by Rev. Philips Payson and James Winthrop, Esq.; nor can we fail to observe the very marked difference between the quality of the science developed in the astronomical papers, as compared to the meagre attempts to discuss chemical subjects. The volume contains only two papers which can be called in any wise chemical, viz., "*Observations upon the Art of Making Steel.* By the Reverend Daniel Little, F.A. A.," in which the author states it as the opinion of writers of the time "that the principal difference between iron and steel consists in this: that the latter is combined with a greater quantity of phlogiston than the former. Phlogiston exists in all inflammable substances, and in some that are not inflammable." And hence in cementation we must use a substance like charcoal, the coal of bones, etc., to form a "cement which contains the greatest quantity of phlogiston." The author's experimental addition to the art of making steel was in the use of the marine plant known as rockweed to form the cementing material, which he found to produce a superior quality of steel. The second chemical paper is a memoir entitled, "*Experiments on the Waters of Boston.*" By J. Feron, a Surgeon-major in the French fleet then stationed near Boston, printed both in French and English. This appears to be the earliest attempt at the chemical examination of water in this country. In the sea-water taken at the head of the "*Long Wharf*," he finds on evaporation 472 grains of solid residue in an English quart, which, dissolved in distilled water, left on the filter 6 grains of "calcareous earth" (probably gypsum). The filtered solution being evaporated, left 400 grains of "sea salt, with an alkaline basis" (sodium chloride), "from 40 to 47 grains of sea salt with the terene basis, or *sal. cathart. amar.*" (meaning magnesium sulphate), "and a small quantity of oil" (meaning probably magnesium chloride). He also examined the pump-water in common use at that time, and finds it near the sea contaminated with marine salts. That from Beacon Hill, Charter street, and New Boston, was nearly free from impurities. He tested their hardness by soap, determined their specific gravity and temperature, and "by the alkaline lixivium used for making Prussian blue" (yellow cyanide of potassium) he proved the absence of "any metallic principle" (*e. g.*, iron), and then compared the pump-water with distilled water, in forming tinctorial infusions in vials of equal size, using as his test equal quantities of pulverized rhubarb exposed to the same degree of heat, and also repeating the trial with cochineal, logwood, and beet juice, detecting in each case the difference of color due to the presence of alkaline salts. He also used nutgalls with "the fixed alkali" (potassium carbonate, probably), "which turned it to a deep green." He inferred from these tests the presence of earthy and alkaline salts, "with some marks of the marine acid." He used silver nitrate and solution of mercury, and obtained the appropriate insoluble chlorides. By a solution of fixed alkali he obtained also a white precipitate of about six grains to the quart, "which dissolved in acid with effervescence" (calcic and magnesian carbonates). Left at rest in bottles, some of these waters gave off "a quantity of air, rising in bubbles to the surface," and let fall a small sediment. "Lime-water dropped into these waters formed a white cloud, and detached a precipitate of the same color." The water of *Beacon Hill* and *Charter street* gave no such precipitate with the alkalies nor with lime-water. He asks if the reaction with lime-water and the escape of air-bubbles does not indicate an earth, suspended by means of a superabundance of air (meaning carbonic acid). He then proceeds to determine the solid residue by evaporation, and with considerable skill to estimate the chief constituents of the saline mass, using the methods of analysis then known. His paper, translated into modern chemical terms, would not be esteemed an unworthy contribution to-day; and considering the fact that there was then hardly one seat of learning in America where chemistry was recognized even by name in the curriculum of study, nor was there then an operative laboratory, we must regard with respect this early contribution to the science. It certainly exhibits a truly scientific spirit, reflected, no doubt, from the French schools, in which the author was probably trained. Dr. Feron communicated to the Academy a "Second Essay on the Boston Pump Waters," which is contained in vol. ii. p. 170 of the *Memoirs of the Academy*, 1790–93.

Dr. Samuel Tenney, surgeon to one of the Massachusetts regiments during the Revolutionary war, being stationed near Saratoga, sent to the Academy at Boston in Sept. 1, 1783, "An account of a number of medi-

cinal springs at Saratoga, in the State of New York." This, I believe, is the earliest record we have of these now renowned mineral springs, which had been first observed by the surveyors only thirteen years before; and prior to Dr. Tenney's visit and description they had been frequented only by a few poor people from the immediate neighborhood. Dr. Tenney very accurately estimates and foretells the importance of these saline waters. He gives a clear and intelligent account of the mode of their occurrence, and shows his sagacity by his experiments made on the spot with only such agents as his medical chest afforded to determine the chemical character of the waters. He distinctly recognizes their alkaline character. One he finds to be a chalybeate, and in all he finds "fixed air" to be the agent holding the "calcareous earth" and iron in solution. He says, "It is obvious these waters are essentially the same with the acidulæ of Pyrmont, Seltzer, etc., which have been so famous in Europe." From the great accumulation of calcareous deposits left by these waters he concludes that the flow of water must have been formerly much greater than at the time of his observations, and he reasons hence that these springs have all the appearance of being in a state of decay. His speculations as to the cause of the fault or break in the rocks along the line of which the springs are situated are curious. He finds the elastic power of "fixed air" set free from the lime rocks, by the "vitriolic acid" which "abounds in the subterranean regions, an adequate cause to produce such an explosion as would burst asunder the most solid rocks, leaving reservoirs to be filled with water charged with carbonic acid, forming a proper menstruum for dissolving the calcareous earth or iron ore which it might meet in its passage." He cites many cases of the medicinal value of the waters administered under his own directions to the men of his regiment.

Dr. Tenney's account of the Saratoga waters did much to bring these springs into general notice. It is curious to compare his chemical results with the recent analyses of the same waters by our colleague, Dr. C. F. Chandler, in evidence of the difference afforded in this comparison of the state of the art of analysis at the two periods, nearly a century apart.

With the exception of two technical papers on the manufacture of solar salt at Cape Cod, and on the manufacture of potashes, the latter by Aaron Dexter, of Harvard, there are no further chemical papers in the volumes of the American Academy for a long course of years.

The Connecticut Academy, and the Weston Meteor, Professors Silliman and Kingsley.—The Connecticut Academy of Arts and Sciences was incorporated by the Legislature of that State in the year 1799. In the first volume of its memoirs, published in 1810, will be found "An account of the meteor which burst over Weston, in Connecticut, in December 1807. By Professors Silliman and Kingsley" (pp. 141–163). No scientific paper had before appeared in the United States which excited so much attention and comment as this. Owing to the extraordinary nature of the phenomena described, and, no doubt, also, to the fairness and vigor of its description, this paper was very generally reproduced. It was read, March 4, 1808, before the American Philosophical Society, and appeared in the Transactions of that Society (vi. pp. 423–443, 1809). Contrary to a standing rule, to take no notice of matters appearing in the public prints, this paper was also read, at the time, before the Royal Society at London, and the French Academy at Paris. Thomas Jefferson, then president of the American Philosophical Society, is reported to have said on this occasion, in the well-known language of David Hume regarding miracles, "that it was easier to believe that two Yankee Professors could lie than to admit that stones could fall from heaven"—a remarkable evidence of the limited knowledge of such subjects then prevailing in this country, even in the minds of the most cultivated people. But it is chiefly with the chemical side of this paper we are now concerned. It contains, under a separate heading, a "Chemical examination of the stones which fell at Weston (Connecticut), December 14, 1807. By B. Silliman, Professor of Chemistry in Yale College." This examination extends to each of the constituent parts of the stone, viz: 1. Of the stone at large. 2. Of the pyrites. 3. Of the malleable iron. 4. Of the black irregular mass. 5. Of the crust. 6. Of the globular bodies. The chemical portion of this memoir is the earliest research of the kind of which we have any account in this country. There was not at that time a laboratory fitted with the appliances needful for accurate analytical research. The weighings were made on a common pharmaceutical balance, with weights of only ordinary accuracy. There was then no book or treatise on analytical chemistry accessible here, beyond the special work of former investigators, given in their memoirs. Prof. Silliman appears to have followed in this case the memoirs of Vaquelin and Howard, in their analyses of the meteoric stone of Benares, and beyond this to have been guided by his own sagacity.

The Oxyhydrogen Blowpipe of Dr. Hare, 1802.—Probably no chemical discovery made in this country has been more generally cited or less generally understood in its scientific significance, than the oxyhydrogen blowpipe of Dr. Hare; or, as it was called by his colleague, Prof. Silliman, "Hare's Compound Blowpipe." Having some knowledge of the facts, I propose to review them briefly, and to show that this was in reality a memorable scientific event.

No one can read the original memoir by Dr. Hare in *Tilloch's Philosophical Magazine* (xiv. 1802, pp. 238–245 and 298–308), without perceiving in it the evidence of a truly philosophical mind, proceeding by successive steps in a most natural order of induction from a simple attempt to improve the ordinary hydrostatic blowpipe to the discovery of a philosophical principle far in advance of the science of the time. Dr. Hare's paper was entitled "Memoir on the Supply and Application of the Blowpipe. By Mr. Robert Hare, Jr., member of the Chemical Society of Philadelphia." ("Published by order of the Society.") The author was at that time about twenty years of age. The Chemical Society of Philadelphia appears not to have been a publishing society, and Dr. Hare's original memoir, although separately published as a pamphlet in Philadelphia in 1802, was never, so far as I can discover, reproduced in any American scientific journal or transactions. It is reproduced as an "Extract" from M. P. Aadet in the *Annales de Chemie*, 30 *Pluviose, an.* xi. (tome xlv. 113–138). A second paper by Dr. Hare, supplementary to his first, appeared in the Transactions of the American Philosophical Society at Philadelphia, in 1804, under the title "Account of the fusion of Strontites and volatilization of Platinum, and also a new arrangement of apparatus" (vi. pp. 99–105). This paper was read June 17th, 1803. In it he reaffirms his former results given in his first memoir, adding those on the fusion of strontia and the volatilization of plati-

num, and describes the form of apparatus executed by Prof. Silliman at Yale College, in which the gases were confined within the pneumatic trough. In this paper, with characteristic generosity, he recognizes his obligations to Prof. Silliman, his associate in conducting these experiments. The term "Compound Blowpipe" was first given to Hare's apparatus by Prof. Silliman, who also in 1812 describes his form of the apparatus more at length in the *Memoirs of the Connecticut Academy*. This paper of Prof. Silliman, "On the powers of the Compound Blowpipe," was reproduced in Bruce's *American Mineralogical Journal*, p. 199.

In the Transactions of the American Philosophical Society, Philadelphia (vol. 111, pp. 328–399), is a paper read May 7th, 1812, entitled "Experiments on the Fusion of various refractory Bodies by the Compound Blowpipe of Dr. Hare. By Benjamin Silliman, Professor of Chemistry and Mineralogy in Yale College." This paper is prefaced by "A section of the Pneumatic Cistern of Yale College, with the Compound Blowpipe of Mr. Hare burning hydrogen and oxygen gas." This arrangement of the oxyhydrogen blowpipe by Prof. Silliman was extensively reproduced in other laboratories, and was adopted substantially by Dr. Hare. The double platinum jet with converging ducts forming the continuation of two solid silver tubes, and uniting in a common passage, somewhat larger just before their exit, at the common orifice below, joined by screws to avoid solder, were Mr. Silliman's mode of construction, and it was with this jet he conducted the "experiments on the fusion of various refractory bodies," as detailed in this paper, which relates the results of experiments upon more than thirty of the most refractory bodies known, many of which had never before been fused. This paper was republished in *Tilloch's Magazine*.

In the third edition of Henry's Elements of Chemistry (1814), edited by Prof. Silliman, the Pneumatic Cistern of Yale College is figured on the frontispiece with the inscription "Showing the compound blowpipe for oxygen and hydrogen from the original constructed by Prof. Silliman, and invented by him and Dr. Hare."

In September, 1816, Dr. E. D. Clarke, the well-known traveller, and then Professor of Mineralogy in the University of Cambridge (England), published simultaneously in the *Quarterly Journal of the Royal Institution* (London), vol. ii. p. 104, and in the *Ann. de Ch. et Phys.*, tome iii. p. 39, his "account of some *experiments made with Newman's Blowpipe, by inflaming a highly condensed mixture of the gaseous constituents of water*," etc. Newman, the well-known instrument-maker in London, had, a few months before (April, 1816), described in the *Journal of the Royal Institution* (vol. i. p. 65), his blowpipe, in which air was compressed by a syringe. He does not appear to have contemplated the use of any gas but common air. Dr. Clarke, in a foot-note to his paper above cited, refers to Dr. Hare's paper of 1802, but he makes no reference to Prof. Silliman's very full statements of his results on the fusion of refractory bodies made in 1811, and published in 1812. That he had not seen this paper, is certainly possible. A comparison of the results obtained by these two observers shows, however, a singular identity in most of the details not easily accounted for. Prof. Silliman, after the publication of Dr. Clarke's paper, made a reclamation, which was published in the *Journal de Physique* at Paris, for January 1818, and is reproduced with comments in the first volume of *Silliman's Journal*, p. 97. Dr. Clarke subsequently published a book entitled "On the Gas Blowpipe" (1819), which at once called out from Dr. Hare his "Strictures," etc., which appeared in the second volume of *Silliman's Journal* for 1820 (pp. 281–302). This is a good example of the vigor and thoroughness with which Dr. Hare was wont to deal with those who encroached on his rights. No explanation was ever offered by Dr. Clarke for his clear trespass upon the researches of his American contemporaries, although the whole case was fairly laid before him.*

We have already mentioned that the American Academy at Boston selected the oxyhydrogen blowpipe of Dr. Hare for the honor of the first award ever made by them from the Rumford medal fund, which had been accumulating on their hands for more than forty years. It was fit that an American discovery which had been almost coeval with the institution of the Rumford medals, should have been selected for this decoration. It might seem ungracious in us to ask why it was so long delayed, seeing it was at length so worthily bestowed.

We have dwelt somewhat at length upon the historical portion of Dr. Hare's discovery; we now return to say a few words of its merits as a discovery.

That Dr. Hare deserved the title of a discoverer. and not merely the lesser distinction of an inventor, will appear, if we remember that he had the sagacity to recognize, in his original memoir, the fact overlooked by Lavoisier and other experimenters in the same field, that in order to obtain the maximum possible effects of heat, the body to be heated must be sustained *in an atmosphere of burning gas*, and that charcoal, impinged upon by a jet of oxygen, did not fulfil this condition. Hence Hare, after discussing the fundamental defects of Lavoisier's methods, says, with great sagacity, "To avoid these evils, it was thought desirable that means might be discovered of clothing the upper surface of any body which might be subjected to this species of operation with some burning matter, of which the heat might be equal to that of the incandescent carbon with which the lower surface might be in contact; or by which bodies might be exposed on solid supports to a temperature equal or superior to that of the porous charcoal uniting with oxygen."

"It soon occurred that these desiderata might be attained *by means of flame*, supported by the hydrogen and oxygen gases; for it was conceived that, according to the admirable theory of the French chemists, more caloric ought to be extricated by this than by any other condition. * * * * *

"Such was the reasoning which originated the desire of employing the flame of the hydrogen and oxygen gases. But before this could be accomplished, it was necessary to overcome the difficulty of igniting a mixture of these aeriform substances without the danger of an explosion."

These are remarkable words to have been written in 1802. They show their author to have possessed equally the higher powers needed to seek for and discover a great principle, and the lesser power to devise the means to apply it in a mechanical combination. The discovery precedes the invention—the discoverer is master to the inventor. Rarely, as in Hare's case, do we find the two sets of powers combined. Every real discovery is the fertile parent of many inventions. Rumford's paper on the "Source of the Heat excited

* A perfectly fair and impartial statement of the facts respecting the blowpipe of Dr. Hare will be found in the *Ann. de Ch. et Phys.*, 1820, tome xiv. p. 302, by Gay-Lussac: "Sur *la Fusion de divers corps refractaires avec le Chalumeau de* Hare." This statement is translated in vol. iii. of Silliman's Journal, p. 87, 1821.

by Friction," which had been communicated in substance to the Royal Society in 1798, was not published in their Transactions until 1800, and could hardly have been known to Hare in 1801, when he made his discovery. Indeed the philosophical conclusions flowing from Rumford's researches on heat were slow in making their way, and the step was a long one from the phenomena of heat as connected with motion, to the fundamental idea developed by Hare—such a long step as to leave the entire originality of Hare in this case beyond question.

Properly considered, the fundamental principle which led Hare to the invention of the oxyhydrogen blowpipe has also led Siemens in our time to the invention of the regenerative gas furnace, by which, as Hare says in the memoir already quoted, "To avoid these evils" (viz., the contact of solid fuel and the loss of heat consequent on its conversion into gas), it was thought desirable that means might be discovered of clothing the upper surface of any body" to be heated "with some burning matter," . . . . "or by which bodies might be exposed on solid supports to a temperature equal or superior to that of the porous charcoal uniting with oxygen." "It soon occurred that these desiderata might be attained by means of flame supported by the hydrogen and oxygen gases."

In the Siemens furnace the objects to be heated are sustained on a solid support in an atmosphere of burning gas, the oxygen of the atmosphere arriving by one inlet, and the combustible gases by another, and the two uniting in a true Hare's blowpipe flame to do their work. The accessory contrivances for the alternation of the flow of gas and air through the regenerative cellular flues of fire-brick, are evidences of a high degree of inventive skill, applied to the solution of a problem which, in its essential features, was clearly set forth by the American philosopher, Robert Hare, in 1802, in his memoir which we have just been considering.

Of Hare's other Contributions to Science.—It is well in this connection to refer briefly to the labors of Dr. Hare in other departments of chemical and physical research.

It will be remembered that the award to him by the American Academy, in 1839, from the Rumford Medal Fund, was equally for his "improvements in galvanic apparatus" as for his blowpipe.

In 1819 Dr. Hare published his memoir entitled, "A New Theory of Galvanism, supported by some experiments and observations made by means of the calorimoter, a new galvanic instrument" (*Silliman's Journal*, i. p. 413). In view of our present notions in molecular physics, we may perhaps smile at the statement by which the author opens his paper. "I have," he says, "for some time been of opinion that the principle extricated by the voltaic pile is a compound of caloric and electricity, both being original and collateral products of galvanic action." Yet we cannot fail to observe that this statement, if clothed in the language of modern science, is a distinct recognition of what we call the correlation of forces. In Hare's calorimeter we have a form of apparatus which is admirably adapted to develop a large quantitative flow, and one which has now a wide use for this purpose, the substitution of plates of carbon for copper and of amalgamated zinc for the unprotected metal, being the only changes which modern art has introduced into Hare's original instrument, long forgotten, and perhaps before unknown to the existing generation, but now revived again, and permanently installed in the laboratory of the physicist.

In 1821 Dr. Hare published his memoir entitled, "A Memoir on some New Modifications of Galvanic Apparatus, with Observations in support of his New Theory of Galvanism" (*Silliman's Journal*, iii. p. 105; also, in the *Phila. Med. Journal*). In this memoir he describes his "deflagrator," which may be considered as a mobilized voltaic pile, capable of instantaneous immersion in the exciting fluid, and of equally instant suspension. In place of the laborious process of filling by hand the troughs of Cruickshank or Wollaston, Hare supplied the means of bringing any number of voltaic couples into immediate action, without the loss of an instant of time, and thus, for the first time, secured a maximum effect, which, in the previously existing instruments, was impossible.

It happened, as a consequence of the general adoption here of Hare's form of the voltaic pile, that powerful deflagrators were in common use in America long before any apparatus of equal power was known in Europe; for it was not until 1836 that Daniell discovered the double-cell battery, and a little earlier that Kempt had shown that amalgamated zinc would resist the local action, which, prior to that observation, prevented the construction of sustained, or so-called constant batteries. In the absence of these two important discoveries, Hare's forms of voltaic apparatus were the best possible, and well deserved the reward they received at the hands of the American Academy. Faraday, in his Experimental Researches, very honorably conceded to Dr. Hare all that his warmest friends could ask. After recounting the steps by which he had himself been led to the same mode of construction, he adds: "On examining, however, what had been done before, I found that the new trough was, in all essential respects, the same as that invented and described by Dr. Hare, Professor in the University of Pennsylvania, to whom I have great pleasure in referring it." (vol. i. p. 345, § 1123, *Experimental Researches*, June, 1835.)

The perusal of Dr. Hare's papers, above referred to, as well as his numerous controversial and other discussions with other authors, will clearly show that he always held his qualities as an inventor quite subordinate to his theoretical views, and that the latter were ever prompting him to new researches. His discussion with Faraday on Induction (*Expt. Res.*, ii. 251, 1839–40), and his letters to Berzelius and to Liebig, on Theoretical Chemistry, are in point. The general index to the first series of *Silliman's Journal* contains the titles of no less than 150 papers by Dr. Hare, upon a great variety of chemical and physical subjects, the mere enumeration of which would far transcend our present limits.

Before leaving this subject, it is proper to say that the deflagrator of Hare in 1822 enabled Prof. Silliman to announce the fusion and volatilization of carbon, and the actual transfer of the volatilized portion of the positive electrode to the negative pole, by which the former is made cup-shaped and diminished in length, while the latter is sensibly elongated (*Am. Journ. Sci.*, [i.] v. 108). This fact was disputed by Vanuxem and others, but was amply confirmed much later by Despretz, who further detected on the walls of the inclosing glass egg, within which the arch for 600 Bunsen couples was brought to bear on the diamond, minute crystals of carbon obtained from the vapor of the volatilized diamond.

On the 15th of May, 1858, Dr. Hare died at the advanced age of seventy-eight years. In the following number of the *American Journal of Science*, his old friend and associate, himself then in his eightieth year,

presented the following tribute to his early and life-long co-laborer, which we reproduce in this connection, even at the risk of some repetition of what has already been said, as a proper supplement to our notice of two of the best known contributors to chemical science in this country of the past generation.

"*The late Dr. Robert Hare.*—During the progress of the forty years of our editorial labors, sorrow has often been awakened as we have been called to record the departure from life of friends and fellow-laborers in the common cause.

"Robert Hare, the distinguished chemist and philosopher, who died in Philadelphia on the 15th of last May in the seventy-eighth year of his age, is entitled to a grateful commemoration in this Journal, to whose pages his contributions were for many years more numerous than those of any other correspondent. The enumeration of the titles merely of about one hundred and fifty articles furnished by him, occupies five columns of the general index of the first fifty volumes of the Journal. He appears in forty-one of those volumes, and in seven volumes of the Second Series.

"For more than half a century his name has been familiar to men of science as a chemical philosopher, and to the cultivators of the useful arts throughout the civilized world.

"Dr. Robert Hare was born in Philadelphia, January 17th, 1781. His father was an Englishman, a man of strong mind, and honored in his adopted country by the public confidence. His mother was from a distinguished Philadelphia family. In early life he managed the business of an extensive brewery, which his father had established, but his strong leaning toward physical science very early manifested itself, and soon led him to abandon the pursuits of a manufacturer and devote his talents and fortune to science. Before the age of twenty he gave evidence of this predilection for scientific pursuits by following the courses of lectures on chemistry and physical science in his native city, and by uniting himself with the Chemical Society of Philadelphia, then embracing the names of Priestley, Sybert, and Woodhouse.

"In 1801 he communicated to this Society a description of the oxyhydrogen blowpipe, which he then called a '*hydrostatic blowpipe*.' Prof. Silliman, having been much engaged with him in a series of experiments with this instrument in 1802–3, subsequently distinguished it as the 'compound blowpipe.' having, in fact, on his return from Philadelphia in 1803, constructed for the laboratory of Yale College the first pneumatic trough combining Dr. Hare's invention; an apparatus subsequently figured and described by Dr. Hare in his memoir 'on the fusion of strontia and volatilization of platinum.'* His memoir to the Chemical Society was separately published in 1801, and was republished in *Tilloch's Phil. Mag.*, London, 1802, and also in the *Annales de Chimie* (1st series), v. 45.

"This apparatus was the earliest and perhaps the most remarkable of his original contributions to science. It was certainly evidence of a highly philosophical mind, that Dr. Hare, in that comparatively early period in modern chemistry, and when the received notions of the true nature of combustion were so vague, not to say erroneous, should have had the acumen to conceive that a stream of oxygen and hydrogen burning together should produce so intense a heat. Lavoisier, certainly one of the most acute of chemical philosophers, and unsurpassed in his skill as an experimentalist, had beaten up the same path so far as to direct a jet of oxygen upon charcoal, and he thus produced a degree of heat by which he fused alumina and other bodies before deemed infusible. He had even brought the elements of water into the same vessel, and had there burned them from separate jets, in his famous apparatus for the recomposition of water. But it seems never to have occurred to him that here was a source of heat greater than any then known. In our view, Dr. Hare's merit as a scientific philosopher is more clearly established upon this discovery than upon any other of the numerous contributions he has made to science. His original experiments were repeated in 1802–3 in presence of Dr. Priestley, the discoverer of oxygen, then on a visit to Philadelphia, and of Silliman, Woodhouse, and others. They were subsequently greatly extended by Prof. Silliman, who, with the apparatus already alluded to, subjected a great number of refractory bodies to the action of the oxyhydrogen jet, and published an account of his results in the *Memoirs of the Conn. Acad.*, May 7th, 1812.

"The discovery of the oxyhydrogen blowpipe was crowned by the Amer. Acad. at Boston by the Rumford medal.

"The historian of science will, in view of the facts here quoted, find it needless to notice the disingenuous effort of Dr. Clarke of Cambridge, England, in his '*gas blowpipe*,' to overlook or appropriate the discovery of Dr. Hare, and the researches of Silliman and others, several years after (in 1819) this discovery had been fully before the scientific world—an effect which must ever remain as a sad stain upon the reputation of this otherwise distinguished man.*

"It is not our purpose here to rehearse the history of Dr. Hare's discovery in full, much less to describe all the modifications which the apparatus has received at the hands of its original discoverer and others. It is well known that in later years he constructed the apparatus on a gigantic scale, with large vessels of wrought iron capable of sustaining the pressure of the Fairmount water-works, and that with this powerful combination he was able to fuse at one operation nearly two pounds of platinum.† In these experiments the metal is held upon a refractory fire-brick, and both are heated as highly as possible in a wind furnace before submitting it to the gas-jet. The product of this fusion from the crude grains is found to be greatly purified, a result probably due to the volatilization at this intense heat of some of the associate metals.

"The employment of Dr. Hare's jet to illuminate lighthouses and signal reflectors under the names of Drummond light and Calcium light, is only another example of the mode of ignoring the name of the real discoverer, of which the history of science presents so many parallels.

"The fertility of Dr. Hare's inventive mind is illus-

* Trans. Am. Phil. Soc., vol. vi. p. 99, and plate 3 (June 17, 1803).

* The reader will peruse with interest, in this connection Dr. Hare's elaborate defence of his own claims and those of his associate, Prof Silliman, against Dr. Clarke's appropriation, in this Journal [1], vol. ii. pp. 281–302, 1820. Dr. Clarke, after a full and spirited protest had been communicated to him, stating fully Dr. Hare's claims and the wrong done him, failed to make any acknowledgment of his error, thus exonerating us from the force of the old maxim, "*Nil de mortuis nisi bonum.*" Dr. Hare heads his strictures on Dr. Clarke's book with the well-known lines of Virgil, "*Hos ego versiculos feci, tulit alter honores,*" etc.

† Roberts in New York has lately with Dr. Hare's apparatus succeeded in fusing perfectly 53 oz. of platinum at one operation, and Deville has by the same means more recently fused one hundred and fifty pounds of platinum at one operation, in obtaining the metal for the new standards of measure.

trated by the numerous and ingenious forms of apparatus which he contrived for research or illustration. To many of these he was led by the necessity of preparing the illustrations for his lectures upon a scale of magnitude adequate to the instruction of the large classes of the Medical School of the University of Pennsylvania. He was called to fill the Chair of Chemistry in that institution in 1818, and continued in the discharge of its duties for nearly a third of a century, and until his resignation in 1847.

"He was fond of graphic illustrations; they abound in his memoirs and in his Compendium and other works, and aided by his lucid descriptions his inventions thus become quite intelligible. Where most instructors are satisfied with less perfect and more simple means and explanations, he seemed to be content with nothing short of perfection.

"During his long course of research and experimenting, he accumulated a vast store of instruments and materials. An inspection of his repositories and the treasures there accumulated filled the observer with astonishment, and in his lecture-room there was always a profusion of apparatus, often instruments of great dimensions, corresponding well with his large mind, with his great physical and intellectual power, and unquenchable ardor. He was himself an able and skilful mechanic, and often worked adroitly at the turning lathe and with the other resources of a well-furnished shop. In his operations he spared neither labor nor expense, and bestowed both munificently for the accomplishment of his objects.

"He devoted great labor and skill to the construction of new and improved forms of the voltaic pile, and it is easy to show, that, owing to his zeal and skill in this department of chemical physics, American chemists were enabled to employ with distinguished success the intense powers of extended series of voltaic couples long in advance of the general use of similar combinations in Europe.

"It was with one of Hare's deflagrators that Silliman in 1823 first demonstrated the volatilization and fusion of carbon, a result considered so extraordinary at the time that it was long received with incredulity. Since the general introduction of Bunsen's battery, these effects are no longer doubted; all Prof. Silliman's results having been confirmed and extended by Despretz, De La Rive, and others.

"The deflagrator was invented in 1820.* Four years earlier Dr. Hare had contrived another instrument which he called *the Calorimotor*. In this instrument great extent of surface was obtained from the combining of many large plates (18″ or 24″ square) of zinc and copper into two series, and plunging the whole at one movement into a tank of dilute acid. The magnetic and heating effects of this instrument were surprising, and to this day no other form of voltaic apparatus appears to occasion the movement of so great a *volume* of heat with so low a projectile or intensitive force. By it, large rods of iron or platinum, when clamped between its jaws, are first fully ignited and then fused with splendid phenomena, while at the same time its intensity is so low that hardly the least visible spark can be made to pass by it through poles of carbon.

"In the philosophy of chemistry, Dr. Hare has distinguished himself for the zeal and logical acumen with which he combated what he conceived to be the errors of the salt radical theory. He was ready at all times to engage in controversy upon any point of theory where he conceived there was an error latent. No one can review the numerous letters which he has addressed to the senior editor of this Journal, to Berzelius, to Liebig, and to Faraday, and published in this Journal, without perceiving that he was no ordinary antagonist.

"In his family and among his friends Dr. Hare was very kind, and his feelings were generous, amiable, and genial, although occasionally his manner was abrupt—from absence of mind occasioned by his habitual abstraction and absortion in thought; his mind was ever active, and conversation would sometimes seem to awaken him from an intellectual reverie. He had high colloquial powers, but to give them full effect, it was necessary that they should be roused by a great and interesting subject, and especially if it assumed an antagonistic form. He would then discourse with commanding ability, and his hearers were generally as willing to listen as he was to speak.

"He was a man of unbending rectitude, and a faithful friend both in prosperity and adversity.

"His frame was robust—powerful and ample in structure, and of strong muscular development, having been invigorated in earlier years by skilful training; and, had there been occasion, he would have made a formidable physical antagonist. His head was large and of noble model; no stranger could meet him without being impressed by a figure of such grandeur and a head and features so remarkable.

"Dr. Hare was an ardent patriot, who loved his country and cherished its institutions not for office or emolument, which he never sought or received, but from pure and lofty motives. He was of the school of Washington—an enthusiastic admirer of that great man—a federalist, while that primeval party had a name and retained vitality—and when it passed by an imperceptible transition into another form, he was found among the whigs. He occasionally wrote upon the great political and financial questions which agitate the public mind. These discussions, like all his writings, were always marked by vigorous thought, large views, and elevated patriotism.

"He was not, however, so exclusively a man of science as to ignore the charms of literature. His particular friends know that his philosophy was sometimes softened by listening to the Muses, and he occasionally indulged in poetical composition.

"Dr. Hare was one of the few life members of the Smithsonian Institution, to which he gave, soon after he resigned his professorship, all his chemical and physical apparatus, which has thus become the property of the nation."

Benjamin Silliman.—At the time when the chair of chemistry was first occupied by Prof. Silliman in Yale College, in 1802, chemistry as a science was almost unknown in the United States, and, as we have seen, very few contributions had then been made to it in this country. Prof. Silliman fully recognized his obligations to Dr. John Maclean, of Princeton, where he made a pilgrimage immediately after his appointment, and from whom he early obtained a list of books for the prosecution of his studies. Princeton was thus an authority in chemistry before Yale had taken her first lessons in this science. Priestley's arrival here in 1794, and his inspiring influence, both by his occasional presence in Philadelphia and by his communications to the American Philosophical Society, naturally made Philadelphia the point of chief attraction in the United States

* Sill. Journal [1], vol. iii. p. 105.

to the chemical student at the commencement of the nineteenth century. Here Professor Silliman found Dr. James Woodhouse filling the chemical chair in the University of Pennsylvania, on whose lectures he was a faithful attendant. But he was not long in discovering that he made more real progress in the study of chemistry by availing himself of the advantages of a small laboratory, which he and a young man by the name of Robert Hare united in fitting up with a little apparatus and limited means of research. There these zealous young students worked together, elaborating the compound blowpipe, previously contrived by Hare, and of which the history has already been given. His chemical work upon the Weston Meteorite has also been noticed. His "Elements of Chemistry in the order of the Lectures given in Yale College" was published in two volumes in 1830, and embraced the fruits of a long course of successful experience in demonstrative chemistry, and was, with the exception of Gorham's, the first systematic work on our science in this country, which was not a reproduction of some European treatise.

Prof. Silliman made important contributions to chemical science, as we have seen; but far more important than his researches, to the advancement of this department of knowledge, was his remarkable power as an expounder of its truths in his lectures. It is not for us to enlarge further upon this subject, nor is it needful, seeing that the work has already been done by the graceful pen of Dr. Fisher, his biographer. It is, however, but just to add, in passing, that between the years 1830 and 1850 Prof. Silliman appeared frequently as a public lecturer on science in other cities and in very distant parts of this country, and was the first college professor who ventured to step from his rostrum to teach the people. With what measure of success he accomplished this task, without loss to the dignity and high office of science, has already been recorded by other pens. That these lectures had an important influence as an active element in the great awakening of the popular mind toward science, elsewhere noticed in this essay, cannot be doubted, and it were easy to trace his influence in deciding the action of some of those who have since made important endowments for science.

His editorial labors, both in the successive editions of Dr. Henry's Chemistry, and far more in the *American Journal of Science*, have already been noticed. He filled the chairs of chemistry and mineralogy at Yale College for fifty years, during which geology, as a science, was developed and added to his duties. By securing early in his career the extensive mineralogical collection of Col. G. Gibbs to Yale College, he gave this department of science great prominence there, and rendered the development of the geological department comparatively easy.

Of his early contributions to chemistry we have already said something; it is hardly needful here to add the titles of his various papers, about sixty of which will be found in the catalogue of the Royal Society.

He was an industrious and zealous worker in the laboratory, and eminently successful as a demonstrator. In 1808 he, immediately upon the announcement of Davy's discovery of the metallic bases of the alkalies soda and potassa, repeated Davy's methods by the voltaic pile, and verified his results (see *Bruce's Journal*, pp. 88 and 134), and he reproduced in full the memoir by Gay-Lussac and Thénard on the furnace process for potassium, in his third American edition of Henry's Chemistry. His scientific life was at many points intimately associated with that of Dr. Hare, and we have already illustrated this fact by what has been said of the researches of the latter philosopher.

Prof. Silliman wrote on many subjects besides science. His "Journal of Travels in England, Holland, and Scotland and of two passages over the Atlantic in 1805 and 1806" (3 vols.), was very generally read, and early made his name widely known. A visit to Europe was then a remarkable event, and no educated American had, before him, recorded his experiences. "Europe Revisited" (2 vols.) was published in 1853, and an earlier volume, "Tour from Hartford to Quebec in the Autumn of 1819," is a pleasantly written narrative, full of interesting historical data with reference to the early occupation of the country by the French.

Adam Seybert is one of the few American chemists who enjoyed the advantage, rare at that time, of a training in the School of Mines at Paris, late in the last century. He has left but few papers, but his memoir, read before the American Philosophical Society, March 10, 1797, entitled "Experiments and Observations on Land and Sea Air," is of interest as the earliest example of such a research on our records. It relates the results of twenty-seven analyses of air made by the author at sea in a voyage across the Atlantic, and also the comparison of these results with other analyses made by him on land, near Philadelphia, by which comparison he reaches the conclusion that the air over the sea is purer than that over the land; that, while the latter varies with locality, the former is nearly constant: and he then modestly ventures the suggestion that "perhaps the impurities are absorbed by the agitation of the waves"—a conclusion to which modern investigation by the use of more exact methods has also arrived. Considering the imperfect condition of eudiometric methods in Seybert's time, his research and conclusions therefrom are decidedly creditable to his skill and sagacity. Dr. Seybert was the father of Mr. Henry Seybert, of whose contributions to chemical mineralogy we shall speak more at length. It was Adam Seybert, who a few years later performed the office of his great namesake in the Garden of Eden, by naming the few minerals then forming the collection of Yale College, when submitted to him in 1803 by Prof. Silliman.

Archibald Bruce, M.D., was both a chemist and mineralogist as well as a man of profound medical attainments. His name is associated with the *American Mineralogical Journal*, of which he was the projector and editor in 1810–14. It is pleasant to recall the fact also that his first chemical analysis "Of native magnesia from New Jersey" made known to science the beautiful mineral found in the magnesian rocks of Castle Point at Hoboken, New Jersey, which now bears the name of Brucite. He had also the sagacity to detect and correctly analyze the red zinc (zincite) of Sussex in New Jersey, associated with the Franklinite, two of the most distinctive and beautiful of American minerals. Some of the French authors still distinguish the zincite, erroneously, as Brucite. He also published a valuable paper "on the ores of titanium occurring within the United States." Dr. Bruce collected a valuable mineralogical cabinet. He died early (in 1818), in his 41st year. A fine engraved portrait of Dr. Bruce is preserved in the first volume of *Silliman's Journal*.

W. Langstaff, M.D., New York.—Dr. Langstaff, when the assistant of Dr. Archibald Bruce, in 1811, made the first American analysis of chondrodite (then called *Brucite*). Indeed we may say this was the first mineral analysis of any difficulty (if we except the

analysis of the Weston meteor by Prof. Silliman in 1807–8) made in this country. Berzelius had failed to detect the presence of fluorine as a factor in this species in his analysis of the variety from Finland. Dr. Langstaff's analysis of the Sparta mineral first detected the fluorine, and his analysis gives very nearly the correct constitution of the species (*Dana, Min.*, 1868, p. 364–65). This fact entitles Dr. Langstaff to honorable mention among American chemists, although I have failed to detect any other example of his work.

Joseph Cloud, Assay Master in the U. S. Mint at Philadelphia, made, in 1807, an interesting research upon a native alloy of palladium and gold from Rio des Mortes, in Brazil. This metal had not before been found combined with gold, and all knowledge of it was confined to Dr. Wollaston's researches in 1802–1805 on its alloy with platinum. Mr. Cloud's paper on the Brazilian alloy of palladium was read before the American Philosophical Society, June 23, 1809, and is printed in the sixth volume of their Transactions, p. 497. This appears to be the earliest research of the kind made in this country. Mr. Cloud followed up the subject by an investigation into the platinum metals, and it is said (*Bruce's Journ.*, p. 43) that he obtained rhodium of remarkable purity, but his paper, if printed, has escaped my search.

William James Macnevin, M.D.—Dr. Macnevin was made Professor of Chemistry in the College of Physicians and Surgeons in New York in 1811. He was educated in Germany, receiving the degree of M.D. in Vienna in 1783, at the age of twenty years. There is a romantic interest connected with the political side of his career as one of the Irish patriots associated with Emmet, Fitzgerald, Tone, etc., with which we now have no concern. In 1826, he was one of the associates with Dr. Francis, Dr. John Griscom, and others in founding the Rutgers Medical College, and taught Materia Medica in addition to Chemistry. Dr. Macnevin published "An Exposition of the Atomic Theory," which was favorably received both in this country and in Europe. Besides editing an edition of Brande's Chemistry, he was also coeditor of the *New York Medical and Philosophical Journal*. His scientific papers, so far as recorded, are:—

Decomposition of Potash. *Am. Med. and Phil. Journ.*, ii. 204–208, 1811.

Chemical Examination of the Waters of Schooley's Mountain. *N. Y. Lit. and Phil. Trans.*, i. 540–557, 1815.

Analyse Eines Krystallisirter Dolomit aus Nord Amerika. *Schweigg, Journ.*, xxx. 89–94, 1820.

Exposition of the Atomic Theory of Chemistry and the Doctrine of Definite Proportions. *Thomson, Ann. Phil.*, xvi. 1820.

Chemische Unterschungen über eine neue art Baryt, den Schoharit. *Schweigg. Journ.*, xxxii. He died July 12, 1841, aged 78 years.

John Gorham, M.D.—Prof. Gorham was the Erving Professor of Chemistry at Harvard University from 1816 to his death in 1827. His one great and lasting contribution to our science was his systematic treatise, published in 1819, in two volumes, 8vo., embracing about eleven hundred pages, under the title of "The Elements of Chemical Science." This work bears ample testimony that the author was a man of ability and thoroughly familiar with his science. His "introduction" is an essay which every chemist to-day can read with pleasure and admire for its truly wide philosophic spirit as well as for its chaste and beautiful style. The whole treatise is, for the time, an admirable performance, and fully justifies the opinion then expressed of it by Prof. Silliman in his notice of the work (*Silliman's Journal*, 1822), that "this work is not surpassed by any one with which we are acquainted, as a perspicuous, chaste, and philosophical treatise." Dr. Gorham had been the fellow-student of Prof. Silliman under Dr. Hope in Edinburgh, in 1804–5.

Dr. Gorham's "Elements" was the first systematic treatise on the science of chemistry by an American author, and deservedly secures honorable mention to his name. His chemical papers appear to have been few. "An Analysis of Heavy Spar from Hatfield" (1815); "Contributions to Chemistry, No. I;" "Indigogene" (*N. E. Journ. Med.*, vi. 1817); "Chemical Examination of Sugar, supposed Intentionally Poisoned" (*Thomson's Am. Phil.*, 1817, x. 197); "Chemical Analysis of Indian Corn" (*N. E. Journ. Med.*, ix. 1820; *Tilloch's Mag.*, lvii. 1821, 311); and "Examination of Calculi from the Sublingual Gland" (*N. E. Journ. Med.*, ix. 1820), are all I find mention of.

One of his pupils, whose own professional eminence gives weight to his words, in a private communication to the speaker, under date of July 27, 1874, says: "Dr. Gorham, who succeeded Dexter in the Chemical Chair (at Harvard), was an accomplished teacher, and exceedingly popular with all the students. The excellent treatise, to which you allude, was written for our benefit, and considered by us all as the sure guide to all the arcana of science, and the book of books, which no future discoveries could ever suffer to be laid upon the shelf as a thing of the past."

"Dr. Gorham died young, for the interests of science and the love of his professional brethren, who followed him as true mourners to an early grave."

Parker Cleaveland.—From 1803 until his death Prof. Cleaveland devoted his life with remarkable singleness of purpose and exclusive assiduity to the duties of his professorship at Bowdoin College, Maine. He at first did all the work there in mathematics, natural philosophy, chemistry, and mineralogy. He was relieved of mathematics by another colleague after some years. His name is inseparable from the early history of American science. Although a good chemist, and during his long life its successful teacher at Bowdoin, his fame rests chiefly and securely on his "Elementary Treatise on Mineralogy," which first appeared in 1816, and in a second revised edition in 1822. The *Edinburgh Review* for September, 1818, at a time when they were not much given to praising American books, said of Prof. Cleaveland's "Mineralogy," "that it would be found to be the most useful work on mineralogy in our language," and advises its republication in Great Britain.

There can be no doubt that the timely appearance of Cleaveland's "Mineralogy" did very much to stimulate scientific progress in the United States, and it was certainly, at the date of its issue, the most important contribution made to American scientific literature. A careful review of it by Prof. Silliman in 1818, will be found in the first volume of the *American Journal of Science*.

James Freeman Dana.—The recognition of chemistry as an element of academic instruction at Dartmouth College in 1820, was signalized by the election of Dr. Dana as their first professor. He had been the assistant of Dr. Gorham at Harvard, where he graduated in 1813. He developed such ability in chemical studies, that in 1815, while yet in his novitiate under Dr. Gor-

ham, he was selected by the university to visit London, and procure for the chemical department at Harvard a new outfit of apparatus, which commission he executed to the complete satisfaction of the authorities. While in London he prosecuted his studies in practical chemistry in the laboratory of Accum, who also had been the instructor of Prof. Silliman in 1804–5, and who had at that time the only laboratory in London open to students. On his return to Cambridge he executed the needful repairs and alterations in the laboratory preparatory to receiving the new apparatus, and was almost immediately appointed assistant to the professor of chemistry.

In the autumn of 1817 he was appointed Lecturer on Chemistry at Dartmouth College, and in 1820 Professor of Chemistry and Mineralogy in the same institution. While yet a student at Cambridge, he received the award of the Boylston prize for a dissertation on the "Tests for Arsenic," and while on his voyage home from Europe he wrote a second dissertation on the "Composition of Oxymuriatic Acid," for which the Boylston premium was again assigned him in 1817. In all respects Dr. Dana was a man of superior qualities, and his brief career, cut short by an untimely death at thirty-three years, is marked by contributions to science of no ordinary merit. His most important original work was his "Epitome of Chemical Philosophy," Concord, New Hampshire, 1825, pp. 221. This treatise, in which he develops the philosophy of the science as it then existed, is an extended syllabus of the lectures delivered by Dr. Dana at Dartmouth College, and is altogether a creditable performance. He was an accomplished experimenter, skilful in devising apparatus and methods, and an eloquent, perspicuous lecturer.

He contributed original memoirs on a variety of subjects; for example:—

In 1819. On a New Form of Electrical Battery (which is a mode of Æpinus's condenser).

1819. "Chemical Examination of the Berries of Myrica Cerifera, or Wax Myrtle." He presents a proximate analysis of the berry.

1819. On the Effect of Vapor on Flame. This short paper has great significance, and the line of research it indicates has never yet been fully worked up.

1820. On the Existence of Cantharidin in the *Lytta Vittatæ*, or Potato Fly.

1822. "Chemical Examination of some Morbid Animal Products." In this paper Dr. Dana gives the results of his examination of a collection of urinary and other calculi in the Anatomical Museum of Harvard College. He detects the error of Brande in mistaking uric acid for muriatic acid in calculi, and shows his sagacity as an analyst by other evidence.

1823. Miscellaneous Notices: 1. Connection of Electricity, Heat, and Magnetism. 2. Preparation of Euchlorin Gas. 3. Concretion from the Tonsil.

1823. "Galvano-Magnetic Apparatus." This is a neat form of floating spiral, like Ritchie's, which was then unknown.

1824. "On the Theory of the Action of Nitrous Gas in Eudiometry." A creditable paper.

1824. "Ignition of Platinum," by Vapor of Ether on Warm Platinum Sponge. "New Locality of Cobalt." This was the "Danaite" or cobaltine of Fredonia, N. H., first noticed by Dr. Dana. Mr. Patten's Air-Pump. All the above in *Silliman's Journal.*

1827. Some Experiments on the Root of *Sanguinaria Canadensis* (*N. Y. Lyc. Nat. Hist.*, ii. 1828, 225). Dr. Dana discovered the alkaloid which he called *sanguinarine*, in the roots of this plant. Dr. A. A. Hayes, then assistant to Dr. Dana, had previously called the attention of his instructor to this plant. See *Silliman's Elements of Chemistry*, ii. 1831, pp. 503–505, for a statement of the case by Hayes. Dr. James Schiel, of St. Louis, has subsequently demonstrated the identity of sanguinarin with chelerythrine (*Sill. Journ.* [2], xx. 220, 1855. See *Gmelin's Hand-Book*, xvii. 156).

Samuel Luthur Dana, M.D., born 1795, died 1868.—Dr. Dana, of Lowell, was for fifty years the acknowledged authority in the United States as a technical chemist. After completing his medical studies in 1818, he soon devoted himself exclusively to manufacturing and technical chemistry, holding the position of chemist to the Merrimac print works in Lowell, Mass., from 1833 to the time of his death, thirty-five years. He is the inventor of what is known as the "American System" of bleaching, which he made known in 1838, in the Bulletin of the Société Industrielle de Mulhouse. By his researches upon the action of cow dung as a mordant, he discovered that this and similar manures acted by virtue of the phosphate of sodium they contain, and led to the use of dung substitutes, independently by Dana in the United States, and by Mercer in England. These researches upon cow dung also led him to investigate the nature of manures in general, of mould and muck, and finally to write his well-known book called "A Muck Manual for Farmers" and an essay on manures which received the prize of the Massachusetts Society for Promoting Agriculture. Dr. Dana, in point of time, originality, and ability, stood deservedly first among scientific writers on agriculture in the United States.

Dr. Dana published a translation of "Tanquerel on Lead Diseases" (translated chiefly by his daughters), his attention having been drawn to the importance of the subject by his researches upon the action of the waters of Lowell upon lead, undertaken by him at the request of the government of that city.

Dr. Dana was a man of a retiring, modest disposition, and he published but little, although the ample stores of his knowledge were always open to those who sought his advice.

John Griscom.—Dr. Griscom was one of the earliest teachers of chemistry in the United States, commencing as a private lecturer in 1806, in New York. Dr. Francis, who was subsequently his colleague in Rutgers Medical College, says, "for thirty years Dr. Griscom was the acknowledged head of all other teachers of chemistry among us" (in New York), "and he kept pace with the flood of light which Davy, Murray, Gay-Lussac, and Thénard and others shed on the progress of chemical philosophy at that day. His calm spirit, his deliberate and grave utterance, his exact diction, the simplicity of his manner, and his unostentatious life, were the characteristics which marked him."

Dr. Griscom contributed for many years abstracts of chemical papers from the foreign journals to the *American Journal of Science*, a service which he performed with habitual exactness. But I do not find record of any original researches by Dr. Griscom, whose activities were consumed chiefly in the duties of instruction, and in various philanthropic labors, to which he devoted himself with much zeal and success.

Prof. Silliman maintained a lifelong correspondence with Dr. Griscom, and in one of his letters written January 15th, 1850, says, in allusion to Dr. Griscom's contributions to the *American Journal of Science*, "but nothing in the miscellaneous department can ever

rival those rich contributions which you made with so much punctuality and judicious selection."

Thomas Cooper.—Dr. Cooper was among the early workers in chemistry in this country. He was a voluminous writer on a variety of subjects, political, ethical, economical, philosophical, and chemical. He filled the chemical chair at Dickinson College, in Carlisle, Pennsylvania, from 1811 to 1814, and after this at Columbia, South Carolina, from 1819 to 1834, where he became President of the University.

Dr. Cooper, in 1811, published in *Bruce's Journal*, pp. 134–139, an "Account of the Decomposition of Potash and Production of Potassium by Heat," accompanied by a plate, showing the apparatus he used. This was done in Priestley's laboratory, at Northumberland, and is the first account we have of the production of potassium in this country by the furnace process. In 1818 Dr. Cooper edited in Philadelphia an edition of Thomas Thomson's System of Chemistry, in 4 vols. 8vo.; and in the same year he published a work on Medical Jurisprudence. He had learned in France the secret of making chlorine from common salt, and attempted to turn bleacher and calico printer at Manchester, but was not successful. His radical politics led him to follow his friend Priestley to America, and he took up his residence at Northumberland as a lawyer, prior to assuming the duties of the chemical chair at Carlisle. He was a free-thinking materialist, and commonly accredited an unbeliever. He died May 11th, 1840, aged 81 years.

Thomas G. Clemson, of Pennsylvania, was one of the small number of Americans educated at the School of Mines in Paris. He is the author of some mineral analyses, and proposed the name *seybertite* for the so-called bronzite, or clintonite of Amity, which he carefully analyzed, and both the name and analysis stand good to-day. Mr. Clemson was, I believe, the first to announce the discovery of the diamond in North Carolina, where he resided from an early period after his return from Europe. If he made later researches, I have failed to find the record of them.

Dr. John Redman Coxe, who in 1809 succeeded Dr. Woodhouse in the medical department of the University of Pennsylvania, has left us some records of his original researches. We may mention especially his paper in *Thomson's Annals of Philosophy*, in 1816, on a Plan for Electric Telegraphy, which long antedates any other American suggestion on this subject since the days of Franklin. Dr. Coxe also wrote on Phosphorus (*Thomson's Ann. Phil.*, 1813, i. 68); Observations on Crystallization (*Ibid.*, 1815, vi. 101–106); On Lead Pipes (*Ibid.*, 1816, viii. 237); Preparation of Phosphuret of Lime (*Journal Royal Instit.*, i. 1831, 172).

William Charles Wells, M.D., F.R.S., the author of the "Essay on Dew," crowned by the Royal Society of London, in 1814, with the Rumford medal, was an American, born in Charleston, South Carolina, in 1747. Few physical investigations can be found on the fair pages of science, undertaken in a purer spirit of research for truth's sake than those which this lonely, austere, and abstemious man carried out in his garden in Surrey, in 1812. His apparatus was of the simplest. With a few small thermometers, some plates of different kinds of metal, a few watch glasses, and small pledgets of swan's down and wool, on the greensward of his little garden in Surrey, during the livelong nights, with the silent stars his only companions, did this philosopher meekly and reverently enter the great temple of nature, an earnest seeker of her secrets—a humble worshipper at her shrine. There he evolved, by patient inductive research, those laws now seemingly so self-evident, which, from the days of Aristotle, had eluded the grasp of previous observers. "Few and simple as were the means with which Dr. Wells conducted his researches, his experiments were so various, so direct, and so conclusive—so sagaciously devised and so admirably executed—that the whole philosophy and economy of the subject which he studied were completely settled."* The simplicity of his recital of his experiences, in his life, is worthy of his earnest devotion to his work while suffering under the distressing disease which in a few years terminated his hard and checkered career.

There is a chastened intellectual joy which flows into the soul, from the contemplation of any ideally perfect work of research like this, which has stood the test of time, and stands now, as it were, a life for a life. It seems like the sea-shell softly to murmur of its parentage, and, as Landor says of the shell—

> "Pleased, it remembers its august abodes,
> And murmurs as the ocean murmurs there."

[Professor Tyndall, in his late address, August 19, 1874, at Belfast, which comes to hand as this is passing the press, says: "In 1813 Dr. Wells, the founder of our present theory of dew, read before the Royal Society a paper in which, to use the words of Mr. Darwin, 'he distinctly recognizes the principle of natural selection; and this is the first recognition that has been indicated.' The thoroughness and skill with which Dr. Wells pursued his work, and the obvious independence of his character, rendered him long ago a favorite with me; and it gave me the liveliest pleasure to alight upon this additional testimony to his penetration."]

James Cutbush was the Professor of Chemistry at the U. S. Military Academy at West Point, and previously at St. John's College, Maryland. His paper "On the Formation of Cyanogen in some Chemical Processes not before noticed" (*Sill. Journ.*, 1822, vol. vi. pp. 149–155) describes the production of cyanogen from the action of nitric acid upon charcoal. He published an elaborate essay "On the Composition and Properties of the Chinese Fire and the so-called Brilliant Fires" in the seventh volume of the *Am. Journ. of Sci.*, pp. 118–140, with numerous pyrotechnic formulæ; and another article in the previous volume (vi. 302), "On the Composition and Properties of Greek Fire," which is full of curious learning. In the Memoirs of the Columbian Chemical Society of Philadelphia, of which society Dr. Cutbush was the president, is a short paper by him "On the Oxyacetate of Iron as a Test or Reagent for the discovery of Arsenic" (1812).

Julius T. Ducatel.—Dr. Ducatel, of Baltimore (born June 6th, 1796, died September 23d, 1849), was the Professor of Chemistry in the University of Maryland, and in 1830 was elected, on the death of Dr. De Butts, to the chemical chair in the medical department of the same university. Dr. Ducatel enjoyed the repute of being an accomplished and successful teacher and lecturer on his science. He had enjoyed in Paris the teachings of Brougniart, Brochant, and Gay-Lussac, with whom he ever maintained a correspondence. His only chemical contribution of which record is preserved, was his "Manual of Toxicology."

Lardner Vanuxem.—One of a small number of Americans who early enjoyed the advantages of a sci-

* From an eloquent tribute to the life and character of Dr. Wells, by Dr. Elisha Bartlett, 1849.

entific training at the School of Mines in Paris, and the associate of Brougniart, Haüy, and other distinguished men, Vanuxem early contributed important chemical and physical memoirs upon American mineralogy, often in company with his friend Keating. These papers are mostly to be found in the *Proceedings of the Academy of Natural Sciences of Philadelphia.* His analyses of phosphate of iron from New Jersey; of tabular spar from Willsborough; of jeffersonite; of zircon, from Buncombe, North Carolina; of marmolite, and other serpentines, are not merely good analyses, but show their author to have had a thorough scientific training. The paper on the "Mineralogy of Sussex County, New Jersey," in connection with Keating (1822) is an admirably prepared memoir. Prof. Vanuxem was for a time in charge of the chemical instruction in the University of South Carolina, at Columbia, South Carolina, under Dr. Thomas Cooper's presidency. He later had charge of one of the divisions of the New York State geological survey, one volume of the final reports being devoted to the record of his labors. He was deservedly held in the highest esteem for his earnest simplicity and steady integrity of character. He died in 1848.

The University of Virginia has been fortunate in its chemical professors. Dr. J. P. Emmett was the first, from 1825, until his death in 1842. He was succeeded by Prof. Robert E. Rogers, who filled the chair until 1852, when it fell to Dr. J. Lawrence Smith, who was followed by Dr. S. Maupin, and he again by the present incumbent, Prof. J. W. Mallet.

John Patton Emmet, M.D.—Dr. Emmet was the Professor of Chemistry from 1824, until his death in 1842, at the University of Virginia. He contributed important memoirs upon both chemistry and physics. His papers "On Iodide of Potassium as a Test for Arsenic," "Upon the Solvent and Oxidating Powers of Ammoniacal Salts," "Bromine and Iodine in Kanawha Salts," "On Formic Acid," and "On the Solidification of Raw Gypsum," were all published in the *American Journal of Science*, where also he was a frequent contributor of papers on electro-magnetism and magneto-electricity, which showed originality and research. His method of evolving sparks and shocks from the common magnet was ingenious and original, and among the very earliest observations in magneto-electricity. I learn from Dr. J. Lawrence Smith that Dr. Emmet left valuable and extended notes of original experiments on light and other subjects, which have not yet been published.

John Torrey, of New York, for more than half a century deservedly esteemed for his exact attainment in science, and for every virtue, although one of the best read chemists and most successful chemical instructors in the United States, has left few records of his work to which reference can be made. He filled successively the Chemical Chairs at West Point; in the College of Physicians and Surgeons in New York; and at Nassau Hall, in Princeton; and for many years was at the head of the chemical department of the United States Assay Office in New York. His most important contributions to science were in the department of mineralogy and botany. His name is inseparably connected with the development of the North American flora. His fine botanical collections are now, by his gift, the property of Columbia College in New York, of which institution he was for many years a trustee.

Dr. Torrey in 1819 discovered that the remarkable fungus found underground in Virginia and elsewhere, and known as *tuckahoe*, or Indian-bread (*sclerotium gigantium*), was composed entirely of a new principle, not before described, and which he called *sclerotin*. Dr. Torrey's original paper on this subject was read before the New York Lyceum of Natural History in 1819, and was published in the *New York Medical Repository* for December, 1820. In 1827, after the publication of Braconnot's paper on *Pectic Acid* (in 1824, *Ann. de Ch. Phys.*, 28, 173; 30, 96). Dr. Torrey republished his earlier paper, with some additions in the *New York Medical and Physical Journal* (vi. No. 4), and showed the identity of the two substances. See *Silliman's Journal*, 2, xxvii. 439, for further remarks on pectic acid, and Dr. Torrey's original discovery of it.

Sketches of the scientific labors and services of Dr. Torrey will be found also in vol. v. *American Journal of Science*, 1873, pp. 324 and 411.

Dr. Torrey published in the *New York Lyceum of Natural History*:—

1824. On Yenite in the United States, p. 51, vol. i.
1824. Account of the Columbite of Haddam, i. pp. 89–93.
1836. Notes on American Minerals, vol. iii. p. 86.
1825. Vauquelinite in the United States.
1848. Vauquelinite in the United States, vol. iv. pp. 76–79.

In the *American Journal of Science and Arts*:—

1818. On Staurotide, vol. i. p. 435.
1820. On Siderographite, vol. ii. p. 176.
1822. On an ore of Zinc at Ancram, vol. v. 235.
1825. On West Point Minerals, vol. ix. p. 402.
1839. On the Condensation of Carbonic, Sulphurous, and Chlorochromic Acid Gases, vols. xxxv. 374 and xxxvi. 394.

Samuel Guthrie, M.D.—Dr. Guthrie, of Sackett's Harbor, New York, deserves honorable mention as one of the earliest laborers in practical chemistry in this country. He was an original discoverer of chloroform, quite independently of the contemporaneous researches of Soubeiran, Liebig, and Dumas—made at the same time, but completely unknown to Guthrie. I have elsewhere recited the main facts of this curious piece of chemical history, and may be permitted to quote it here.*

"So early as 1796, an association of four Dutch chemists, who had already discovered the rich hydrocarbon gas, long known as heavy carburetted hydrogen gas, or olefiant gas, and now called ethylene or hydrogen-dicarbide (C_2H_4), studied the effects produced from mingling this hydrocarbon with an equal volume of chlorine gas over water. They saw that the volume of the mixed gases rapidly diminished, with a notable elevation of temperature and the appearance of a dense oily-looking liquid, collecting on the sides of the bell-jar and the surface of the water, and quickly sinking to the bottom. Collecting this oily liquid and washing it clean of adhering chlorine, in alkaline water, and in pure water, it was found to be a new substance of a highly agreeable ethereal odor, and distinctly sweetish aromatic taste, neutral to tests, and nearly insoluble in water, to which, however, it imparted its taste and odor, but quite soluble in ether and alcohol. It was wholly unaffected by concentrated sulphuric acid even with the aid of heat.

* "A Century of Medicine and Chemistry:" A Lecture Introductory to the Course of Lectures to the Medical Class in Yale College, 1871.

For many years its real constitution remained unknown, and it was shown only as one of the curiosities of the chemist's laboratory, under the name of 'Oil of the Dutch Chemists;' the name olefiant gas having had its origin from the oil-producing property, which this gas developed in its action with chlorine. Analysis has long since shown that this chlorine compound of the Dutch chemists is a simple union of one molecule of ethylene with two of chlorine, and that it may properly be called the chloride of olefiant gas. I have been the more particular in noticing the discovery of this remarkable substance because it has acquired considerable notoriety from the fact that it was early and most naturally confounded with chloroform, to which, in sensible and physiological properties, it bears a remarkable resemblance. It was long known as 'Chloric Ether,' a name which conveys a false meaning, since there is nothing in the chemical constitution of the body which in the least resembles the ethers.

"In 1831 appeared the second volume of 'Silliman's Elements of Chemistry,' in the order of the lectures then given in Yale College, in which the Dutch liquid was spoken of in its physiological relations, with the remark that, 'Its medical powers have not been ascertained, but from its constitution and properties it is highly probable it would be an active diffusive stimulant.'

"This remark immediately attracted the attention of Dr. Samuel Guthrie, of Sackett's Harbor, New York, a man of an active and original mind, much devoted to practical chemistry, who at once conceived that he might obtain the so-called 'chloric ether' in greater abundance and at a cheaper cost by distilling together alcohol and chloride of lime (bleaching powder). His success was remarkable, and he obtained the alcoholic solution (of chloroform) in great abundance, describing his process in a short article in *Silliman's Journal of Science* for January, 1832; and subsequently, in July of the same year, he states with more detail the precautions he adopted to obtain the product pure, and especially, free from alcohol. It is remarkable that in his second paper he describes in full the method of testing the purity of the substance by agitation with concentrated sulphuric acid. There is no question that Dr. Guthrie was entirely original in his method of producing 'chloric ether,' as it was then called, and it is no abatement of his sagacity that he was not aware that, earlier in the same year in which he described his process, a French chemist, Mr. Soubeiran, had devised and described the same method in a memoir entitled, '*Researches on some Combinations of Chlorine*,' which appeared in the *Ann. de Chemie et de Phys.* for Feb. 1831. Soubeiran calls the product 'a new ethereal liquid of a constitution unlike any before known to chemists,' and also gives us the name chloric ether (*ether chlorique*). The term 'chloric ether' had also been used by Dr. Thomson in 1820 to describe the oil of the Dutch Chemists. Soubeiran gave two analyses of this product, which, while they prove that the body is not the 'Dutch liquid,' failed to reveal its true constitution, which was first given by Dumas in 1834, in a memoir published by him in the same journal, and in this paper Dumas then gave to the new body the name by which it has ever after been known, *chloroform*.

"Such, in brief, is the history of one of the most remarkable bodies ever discovered. You will understand that while the 'chloric ether' of Guthrie was a misnomer, the substance which he produced was *chloroform*, and that the first use made of this agent in medical practice was at the suggestion of Prof. Silliman, to Dr. Eli Ives, formerly Professor of Theory and Practice in this college in 1832. Dr. Ives's note on his experience will be found in *Silliman's Journal*, vol. 21, for July, 1832. The case in which he employed it was one of asthma in an aged person, who was relieved of a severe paroxysm by its use 'more suddenly than she had been in any previous illness of the kind.' Thus the therapeutic history of chloroform had its commencement from the teachings and practice of the Yale Medical School."

The question of absolute priority of the discovery of chloroform may give it to the French chemists Souberaine, but a committee of the Medico-Chirurgical Society, of Edinburgh, have awarded to Dr. Guthrie the merit of having first published an account of its therapeutic effects as a diffusible stimulant in 1832. Chloroform is, therefore, fairly to be claimed as an American discovery. Guthrie also experimented with a boldness and intrepidity amounting almost to rashness in the preparation of fulminating compounds, of which he manufactured large quantities, of various and original constitution, for commercial purposes. His papers on this subject in vol. xxi. (1832) of the *American Journal of Science* disclose his power as an originator of new methods in chemistry. This is true, also, of his process for the rapid conversion of potato-starch into sugar, printed in the same volume.

George T. Bowen, whose early death, in 1828, at Nashville, where he had just assumed the duties of the chemical chair in the University of Nashville, deprived chemical science of a zealous votary. Such was his devotion to chemistry that, while an undergraduate at Yale College, he was permitted, contrary to all precedent in those days, to devote all the time he could spare from his other studies to laboratory work, under the instruction of Prof. Silliman. Here he made original observations (1822) "On the Electro-magnetic Effects of Hare's Calorimeter," and "On a Mode of Preserving in a Permanent Form the Coloring Matter of the Purple Cabbage as a Test for Acids and Alkalies." He has left us analyses and descriptions of several minerals, *e. g.*, of the scheelite of Lane's mine; of Sillimanite, which he proposed as a new species; of the silicate of copper from New Jersey; of a variety of serpentine which he called nephrite, from Smithfield, Rhode Island; and of pyroxene-sahlite from near New Haven. All this he did chiefly before 1822, and prior to commencing his medical studies in Philadelphia, where also he was a devoted follower of the meetings of the Academy of Natural Sciences, contributing to their memoirs and discussions. Dr. Bowen was born at Providence, Rhode Island, March 19th, 1803, graduated at Yale College in 1822, was elected Professor of Chemistry at Nashville in 1825, where he died October 25th, 1828, in the 26th year of his age.

Dr. Gerard Troost succeeded Dr. Bowen in the chemical chair of Nashville University in 1828, where he served as Professor of Chemistry, Geology, and Mineralogy until his death in 1850. Dr. Troost was a native of Bois le Duc, in Holland (born March 15th, 1776). He was educated at Amsterdam and Leyden, studying medicine and chemistry. Having great skill in crystallography, he was in 1807 sent to Paris by Louis Bonaparte, to pursue his favorite studies under the renowned French mineralogist Abbé Haüy. In 1810 he came to America and settled at Philadelphia, where he was one of the founders, and the first President of the Academy of Natural Sciences. He was a constant contributor to the early volumes of the Transactions of the Academy. His papers were chiefly mineralogical,

and especially crystallographical. His paper on Pyroxene, in the *Annals of the Maclurean Lyceum*, is a valuable contribution.

In 1814 Dr. Troost established works for the production of alum at Cape Sable, Maryland, which was one of the earliest chemical industries in this country, and, if I mistake not, the first manufactory of alum.

To his well-directed zeal and industry science owes much for its progress west of the Alleghanies. He instituted the geological survey of Tennessee, and for eighteen years was the geologist of that State, carrying on his work of exploration under many discouragements, and almost unrequited, until his death on the 14th of August, 1850.

He added largely to our knowledge of meteoric bodies, having been fortunate in collecting a great number of both stony and iron masses, fallen or found in his immediate vicinity, and the chemical and physical history of which he accurately studied. His memoirs on these bodies will be found in the *Amer. Journ. of Sci.* With surprising industry and success, considering his remote and comparatively isolated situation, he amassed one of the most valuable collection of minerals and fossils ever formed in the United States, sparing neither labor nor expense to this end. Fortunately his collection escaped unharmed the ravages of war, thanks to the timely care and skill of one of Dr. Troost's sons, and of Dr. J. B. Lindsley, President of Nashville University, although his valuable scientific library was scattered and destroyed. The catalogue of Dr. Troost's mineral collections forms two stout manuscript volumes, written in the clear hand of the author, and describes 13,582 numbered and ticketed specimens, with their crystallographic and physical characters carefully distinguished. This collection, together with the fossils (which are also very valuable), has lately been secured to the Public Library of Louisville, Kentucky, chiefly by the exertions of Dr. J. Lawrence Smith, at a cost of $20,000. This collection is especially rich in crystallized specimens and varied forms, to the study of which Dr. Troost devoted special attention. The catalogue, we are informed, is to be printed in detail. A sketch of the life of Dr. Troost, by Dr. Philip Lindsley, will be found in vol. i. p. 539 of the works of the latter.

Denison Olmsted.—Although Prof. Olmsted's fame rests upon his astronomical and more especially upon his meteorological studies, and his discussion of the great meteoric shower of 1833, yet we remember with satisfaction that he was also a chemist. From 1817 to 1825 he filled the chair of chemistry in the University of North Carolina, where he signalized his term of duty by inaugurating and carrying forward, gratuitously, the first attempt ever made in the United States toward a geological survey of a State. His report, in two parts, appeared in 1824 and 1825, filling only about 140 octavo pages. He also read before the Connecticut Academy, in 1826, after his transfer to the physical chair at Yale College, a "Memoir on the State of Chemical Science," which may be read now with curious interest, as a record of the then existing state of philosophical opinion in our science. It may be found in the XIth and XIIth volumes of *Silliman's Journal*. It is noteworthy that no similar attempt has since been made by any American chemist, until Dr. Gibbs's Report on the Recent Progress of Organic Chemistry (*Proceed. Amer. Ass.*, ix. pp. 37–61, 1855).

Considering the rudimentary state of geology and its associate sciences in 1821, Prof. Olmsted's labors as the pioneer in this department of exploration must ever be considered as eminently honorable to his scientific grasp and ability.

Denison Olmsted, Jr.—This promising chemist, son of the former, died at the early age of twenty-two years, in 1846. He had been for two or three years before an assiduous student in the laboratory of Yale College, where the writer had the happiness to count him as one of the earliest of his pupils in the incipiency of the "Yale Scientific School." His analytical work during that period will be found on record. For a year before his death he held the post of chemist to the geological survey of Vermont, and he was honored shortly before his death by an appointment to a similar situation in Canada, to which our distinguished colleague Dr. Hunt, also taken from the Yale Analytical Laboratory, succeeded. His mineralogical cabinet, gathered by himself, now forms the nucleus of the collection in Beloit College.

W. W. Mather.—Prof. Mather, who died, acting President of the University of Ohio, at Columbus, is better known to this generation as the author of the Report on the First District, in the Geological Survey of New York (1843), than as a chemist. But, if we turn to the 27th volume of the *American Journal of Science* for 1835, pp. 241–267, we shall find an elaborate memoir entitled "Contributions to Chemical Science by W. W. Mather, Assist. Prof. of Chemistry at the U. S. Military Academy, West Point."

This memoir is upon—I. Chloride of Aluminium and its Analysis. II. Hydrated Chloride of Aluminium. III. Crystallized Tin from Solution. IV. Georgia Gold. V. Silver of Lane's Mine. VI. Iodide of Potassium and Platinum, or Iodo-platinate of Potassium. VII. Chloriodide of Platinum. VIII. Crystallized Perchloride of Platinum. IX. Amalgam of Platinum. X. Iodide of Mercury. XI. Solubility of Bitungstate of Ammonia. XII. Disulphuret of Bismuth.

An examination of this memoir will show that it is the work of a chemist of unusual ability. The author presents a great number of analyses by himself made with much care, and details all his processes. He gives a new determination for the atomic weight of aluminium, prompted to it by a discrepant statement in Berzelius (*Traité de Ch.*, ii. 373) by which the numbers representing the composition of alumina are transposed. The whole paper is a creditable one, and up to its date was the most elaborate original research in inorganic chemistry which had been made by any American chemist, so far as I have seen.

Prof. Mather also contributed papers "On the principles involved in the reduction of iron and silver ores, with a suplementary notice of some of the principal silver mines of Mexico and South America" (*Sill. Journ.*, i, xxiv. 1833, pp. 213–237). In this elaborate memoir the author discusses the chemistry of the Mexican silver processes, before that time almost completely unknown in this country. His paper contains a great amount of useful information.

"On cupellation, an easy, an accurate, and new method" (*Sill. Journ.*, i, xxxv. 321, 1839).

"On the crystalline form of iodine," with figures (*Sill. Journ.*, 2, xviii. p. 35, 1830).

George C. Schaeffer.—Prof. Schaeffer, who died in 1873, at Washington, was long justly esteemed as one of the best read chemists of his time. He published but little, but the student of American chemistry will find in his papers "On perchromic acid;" "On the manufacture of ice;" his "New test for nitrates and nitrites," and "On the origin of nitrites," evidence of

his original power. He adopted what are now the accepted views in chemical philosophy long in advance of the great majority of chemists everywhere.

Nor can we forget his "Chemical abstracts," which for several years he supplied to the *American Journal of Science*, during the first decade of its second series, over the familiar initials of G. C. S.

Prof. Schaeffer for a time filled the chair of chemistry in the College at Danville, Ky. But the duties of instruction were less congenial to his tastes than the more quiet pursuits of original study, and he soon retired to the librarianship of the U. S. Patent Office, where he was in his element, and where he remained until his death, always honored and esteemed as a man of varied and exact learning.

All his memoirs here cited are to be found in the *American Journal of Science and Arts.*

Lewis C. Beck.—Dr. Beck filled the chair of chemistry in Rutgers College, New Jersey, and at the Albany Medical College. His industrious habits and great devotion to science enabled him amid the constant drag of routine duty to make important contributions to science, in botany, medicine, and chemistry. His most important work was his "Mineralogy of New York" (1842) forming one of the quarto volumes of the Reports on the Geological Survey of the State. In this work occur many chemical analyses of minerals, mineral waters, and the like, made by the author, as well as of hydraulic limestones and other economic products. He was also an early contributor to general chemistry, and published, in 1827, "General views on the formation of phosphuretted hydrogen;" in 1828, "On the nature of bleaching and disinfecting compounds;" "On the functions of nitrogen in respiration;" "On the commercial potashes of New York;" "On wines and other fermented liquors;" and "On adulterations of various substances used in medicine and the arts," etc. At the request of Prof. Henry, Dr. Beck commenced in 1848 a laborious series of "Researches on the breadstuffs of the United States," afterwards published as a report by the United States Patent Office, at Washington.

He was a man of retiring habits, great modesty, and his personal character was such as to gain him numerous and attached friends. He died in April, 1853, in his fifty-fifth year. Dr. Beck was the author of "A Manual of Chemistry" (1831), which passed through four editions.

J. W. Bailey.—The untimely death of Prof. Bailey deprived American science of one of her most devoted and successful workers in the fulness of his powers. Prof. Bailey was a chemist who, in the discharge of the duties of the chemical chair in the United States Military Academy at West Point, New York, gave good evidence of his ability, both as a teacher and investigator; although his devotion to microscopical researches, with such eminent success, has almost led us to overlook his earlier contributions to our science. Thus, for example, his tests for nitric acid, the double cyanide and iodide of mercury, and for sulphur by Playfair's nitro-prusside when used indirectly to detect sulphur in bodies like albumen, horn, hair, feathers, mustard-seed, etc. His paper "On the Common Blowpipe," and his note on the curious effects of a current of air on the flame of lamps, are evidences of his tact and neatness in chemical manipulation. His papers on the non-existence of polarizing silica in the organic kingdoms, and especially his beautiful researches in 1843 "On the crystals which occur spontaneously found in the tissues of plants" (*Sill. Journ.*, 1, xlviii. pp. 17–32, with a plate, 1845) are fine examples of micro-chemistry, and are characterized by a neatness which is found in all the work of this eminent and lamented investigator, and fully illustrated by his own pencil, which he held with great skill. A sketch of Prof. Bailey's life and scientific labors, by Dr. A. A. Gould, will be found in the *American Journ. of Science*, 2, xxv. p. 133, 1858. He died February 27, 1857, at the age of forty-six years.

Alexander Dallas Bache.—Few probably of the younger chemists of this day look upon the late renowned chief of the United States Coast Survey as a chemist. But his encyclopædic knowledge embraced almost the entire circle of the sciences. He was chosen, only three years after his graduation at West Point, and when only twenty-two years of age, to the chair of Natural Philosophy and Chemistry in the University of Pennsylvania, at Philadelphia, which he held for seven years. During this time he published several chemical and chemico-physical articles, as that "On the Specific Heat of the Atoms of Bodies," in which he maintained that the best data then known (1828) failed to support the doctrine that the specific heat of atoms is the same for all bodies; and "On the Inflammation of Phosphorus in a Vacuum or Highly Rarefied Medium," 1830, a research he never fully completed. In 1832 he published a translation in *Silliman's Journal*, of the "Essay on Chemical Nomenclature Prefixed to the Treatise on Chemistry; by J. J. Berzelius," in which, as is well known to all students of the literature of our science, the distinguished chemist of Stockholm proposed the terminology which is now, after more than fifty years, come fully into vogue. In his paper entitled "Remarks on a Method proposed by Dr. Thomson for Determining the Proportions of Potassa and Soda in a Mixture of the Two Alkalies, with the Application of a Similar Investigation to a Different Method of Analysis," he generalizes the special case given, and shows that the principle to which these results refer themselves may be used with great effect in avoiding a difficult step in chemical analysis, by the substitution of a less direct but more simple one, aided by easy calculations, and well deserving the attention of analytical chemists (*Franklin Institute Journal*, 1836, xvii. pp. 305–309).

In molecular physics Prof. Bache's "Inquiry in Relation to the Alleged Influence of Color on the Radiation of Non-luminous Heat" (*Silliman's Journal*, 1836, 1, xxx. pp. 16–28), has become classic. It is almost needless to say that he proved by it the fallacy of the notion, till then commonly received, that color did influence the radiation of non-luminous heat. It is plain, that, had he not been called to a wider field of usefulness in the administration of great public trusts for science at Girard College, and later and chiefly of the Coast Survey, he could easily have obtained great prominence in chemical research.

Wm. J. Taylor.—This chemist has left us a number of mineral analyses. He was a critical mineralogist and competent analyst. His most elaborate research was an extended memoir on Rock Guano, published in 1857 (*Proceedings of Academy of Natural Sciences*, and *Silliman's Journal*, xxiv. No. 71, pp. 177–188), with numerous exhaustive analyses, and copious references to the literature of the whole subject. He has also published an "Examination of the Meteoric Iron from Xiquipilco, Mexico," with minute analyses (*Silliman's Journal*, 1856, xxii. p. 374, and *Proceedings of the Academy of Natural Sciences*, Philadelphia, viii. No.

3); and has described lecontite, a new mineral species, a double sulphate of ammonia and soda with potash, containing two equivalents of water, and yet homomorphous with the group of anhydrous sulphates. Mr. Taylor, besides publishing other mineralogical notes, has translated Janoyer on the "Influence of Sulphur on Iron (*Silliman's Journal*, 2, xxiv. 330). We have to lament Mr. Taylor's early death.

J. E. Teschemacher of Boston is well remembered as an acute and exact scientist, expert especially in analytical chemistry and in the determination of mineral species, using the blowpipe with remarkable skill and facility. A full list of his scientific papers will be found in the *American Journal of Science*, vol. xvii. p. 294, 1854, more than thirty in number, mineralogical, chemical, and chiefly botanical. Mr. Teschemacher was all his life engrossed in commercial affairs, and made science his recreation, doing more good work than some who have command of all their time for science.

James Davenport Whelpley.—Dr. Whelpley contributed a remarkable paper to the philosophy of chemistry in 1845, entitled "Idea of an Atom, suggested by the Phenomena of Weight and Temperature" (*Silliman's Journal*, 1, xlviii. 352–368). This paper embodies views entirely original with the author, but in which he was partly anticipated by Faraday's paper in 1844, on the "Nature of Matter" (*Phil. Mag.*, February, 1844, p. 136). But Whelpley's paper anticipated the subsequent notions of Faraday as set forth in his "Thoughts on Ray Vibrations" (*Phil. Mag.*, May, 1846). A review of these opinions showing the priority of Whelpley's statements will be found in *Silliman's Journal*, 1846, 2, ii. 401. Dr. Whelpley is also the author of two remarkable "Letters on Philosophical Induction," and on "Philosophical Analogy," which discuss principles fundamental in scientific methods.

John Pitkin Norton, Professor of Scientific Agriculture in Yale College, was appointed to the place he filled so well in 1847. Cut off at the early age of thirty years he has yet left us the record of a well directed life, crowned with honorable distinction as an original investigator in chemistry. After spending two years in attending the lectures of Prof. Silliman, and in study and research in the analytical laboratory of B. Silliman, Jr., he went to Scotland, where, as the student of Prof. James F. W. Johnston, he won the prize of the Highland Society, of fifty guineas, for his comprehensive and able research upon the Oat; an investigation which led the way to the later researches of the same class in this country and in Europe. In Utrecht, under Mülder, he prosecuted his studies in agricultural and physiological chemistry, of which his memoir on the protein bodies of peas and almonds is in evidence. In 1847 he joined Prof. Silliman, Jr., as a colleague in the duties of the Analytical Laboratory of Yale College, which drew to its walls an increasing number of pupils, and soon developed into the "Yale Scientific School," now the "Sheffield Scientific School." Prof. Norton was an industrious author and published during his term of duty his "Elements of Scientific Agriculture," and edited with valuable notes and corrections, Stephen's "Book of the Farm," in two volumes. He wrote a memoir on the potato disease, and was a constant contributor to the *Albany Cultivator*, in a series of letters written both from Europe and after his return. These letters were always remarkable for sound judgment, thorough accuracy and fulness, and the lively style in which they were written.

Among the class of practical agriculturists and students who came up to attend Prof. Norton's first course of lectures on Scientific Agriculture, in January, 1848, were several young men, then unknown to fame, upon two of whom his mantle fell, and is now borne in the persons of Prof. William H. Brewer, and Prof. Samuel W. Johnson, of the Sheffield School, worthy successors in his own chosen field of study and authorship.

In the winter of 1851–52, Prof. Norton entered with zeal into the plan of establishing at Albany a university in which agriculture and its connected sciences should receive the direct patronage of the State. In carrying out this effort he was compelled to travel twice in each week during the winter from New Haven to Albany and back, giving three lectures in each place. This exertion proved too much for his powerful frame, and developed the latent seeds of pulmonary disease, which cut him down just as he had fairly entered on the wide field of his usefulness, perfectly fitted for the work, and enjoying the entire confidence alike of the agricultural community and of men of science. He was a man of noble generosity and the highest moral and scientific excellence.

Evan Pugh, Ph.D., F.C.S.*—Few American teachers of chemical science have attained a nobler fame than Dr. Evan Pugh, late President of the Agricultural College of Pennsylvania. A blacksmith's apprentice at the age of nineteen, he bought out the residue of his time and supported himself by manual labor while he received a year's instruction at the seminary of Whitestown, N. Y. He had fallen heir to a small estate, including a small academy, or private school, at Oxford, Chester County, Pennsylvania, his native place; and, removing thence, he conducted the school successfully for about two years. At this time Dr. Pugh manifested great interest in the educational reform which had lately commenced in Pennsylvania, and the manner in which he discussed the various subjects which engrossed the attention of the educators of that time, showed that he possessed in an eminent degree those logical and analytical qualities of mind which are characteristic of truly scientific men. He was an ardent advocate of phonetic spelling, and had himself attained great proficiency in the use of phonetic short-hand, a method of writing which he continued to employ, on account of its labor-saving qualities, for making notes, etc., throughout his life.

In 1853 he decided to sell his estate and academy, which had become under his management a flourishing institution, in order to obtain means by which he might secure for himself a European course of scientific instruction. His friends protested vigorously against this step, but he was not to be deterred; he went the same year to Europe and spent four years in the universities of Leipsic, Göttingen, and Heidelberg, and in Paris, a most diligent and successful student of natural and mathematical science. At Göttingen he honorably sustained the examinations for the degree of Doctor of Philosophy.

Although he seemed, while in Europe, to allow his course of studies to shape themselves by a sort of prescience, as it were, definitely towards his future career, he yet found time to study, as he had the capacity to master, the highest mathematics, besides making a number of chemical investigations of no slight import-

* This notice of Dr. Pugh has been prepared by Mr W. S Waring.

ance, and which form the subjects of his principal published contributions to science, viz.:—

"Hämatinsalpetersäure identisch mit Pikraminsäure," *Journ. für Prakt. Chemie*, lxv. 362.

"Miscellaneous Chemical Analyses," Inaugural Dissertation, Göttingen, 1856.

"On a New Method of Estimating Nitric Acid," *Quart. Journ. Chem. Soc.*, xii. 35, and

"On the Sources of the Nitrogen of Vegetation, with special reference to the question whether plants assimilate Free or Uncombined Nitrogen," *Philosophical Transactions*, part ii., 1861, 146 pp., 4to., with plates.

This last-mentioned investigation was made in connection with Messrs. Lawes and Gilbert; but Dr. Pugh's share in the work was by no means the least. It appears that while in Paris Dr. Pugh addressed to Mr. J. B. Lawes, the distinguished English agriculturist, so well known by the numerous and valuable researches carried on at his estate of Rothamstead, a proposition to undertake a new investigation of the question, then so vigorously mooted in France between Boussingault and Ville, as to the assimilability of free nitrogen by vegetation. Mr. Lawes received this proposition favorably, and signified his willingness to have the research carried on in his laboratory and to defray all the costs, provided Dr. Pugh could satisfy him of his ability to estimate nitrogen with a certain degree of precision. Dr. Pugh repaired to Rothamstead, and his skilful application of volumetric methods satisfied Mr. Lawes.

The question which Dr. Pugh undertook to decide was one that had been raised more than half a century before by Priestley and Ingenhouse on the one hand, who thought they had observed that plants absorbed the free nitrogen of the atmosphere, and Sennebier and Woodhouse on the other hand, who negatived this opinion. In 1837 the subject was taken up again by Boussingault, who had the sagacity to apprehend the importance of closely investigating the sources of the nitrogen periodically yielded by a given area of land, over and above that which was artificially supplied to it. After a series of experiments extending over a period of 17 years, Boussingault concluded that plants did not assimilate free nitrogen. But it happened in the mean time that M. Georges Ville, of Paris, had, from a series of investigations made by him from 1849 to 1852, which seemed to show an enormous assimilation of nitrogen by the plants with which he experimented that could not be accounted for otherwise by him, announced that the free nitrogen of the atmosphere was assimilated by vegetation. Such strikingly different results at once excited great interest among chemists and vegetable physiologists, and a commission was appointed from the French Academy of Sciences to superintend the conducting, under M. Ville, of a new set of experiments at the Muséum d'Histoire Naturelle, in 1854–5. The report of this commission only tended to confirm the conclusions already drawn by M. Ville. Other experiments were made by MM. Cloez, Gratiolet, DeLuca, Harting, and Petzholdt, whose conclusions were nearly as conflicting as those of MM. Boussingault and Ville themselves.

The researches, however, which were instituted by Dr. Pugh, and to which he devoted two years of nearly constant labor, were characterized with such comprehensiveness in their details, skill and ingenuity in the construction of apparatus and cautions against error, and withal such a rare degree of penetration to discover the many collateral questions involved, and acuteness in their solution, that the conclusions which they established have never since been questioned.

Besides establishing the conclusions of M. Boussingault, these investigations supplied a great amount of evidence in relation to rotation of crops, etc. etc., of vast importance to agricultural science, and opened a rich field of inquiry in vegetable physiology which promised the most important results, had Dr. Pugh remained at Rothamstead to prosecute these researches.

But, while yet there, he received the offer of the presidential chair of the Agricultural College of Pennsylvania from its trustees, who had heard of the rare ability he had already evinced; and although Mr. Lawes, who not only admired his abilities, but was greatly attached to him in friendship, was anxious to retain Dr. Pugh in his laboratory at a handsome remuneration, and notwithstanding the latter was passionately fond of cultivating the fields of scientific research, he returned home in the autumn of 1859 to assume the position which had been offered him.

Willingly renouncing the brilliant career which he was doubtless aware lay before him in case he should continue his researches, he recognized the duty he owed his country, and assumed the nobler and more enduring work. It was a controlling idea with him, that the teacher lives a second generation in the mental developments of the taught, and that to be a benefactor to his race the student must be the medium through which he should operate upon the great world around him.

When Dr. Pugh assumed the presidency of the Pennsylvania Agricultural College, the expediency of combining manual labor with thorough study in an institution of learning was an open question, all previous attempts of the kind both in Europe and America having resulted in signal failures. He had, however, perfect faith in a system which he believed was calculated, above all others, to develop mental and physical strength as well as practical knowledge. Referring once to the well-known fact that it is not sufficient to have spent a certain number of years within the walls of a college or university in order to secure a respectable education, he said, "An English friend, himself a university graduate, once remarked to me that he could point to artisans in the workshops of England with better trained minds, as evinced by greater power of following up any connected train of thought, than could be found with many persons who had spent years at the time-honored universities of Oxford or Cambridge."

With the eyes of the friends of agricultural education in every civilized country resting upon the experiment, he had the courage to undertake to demonstrate its practicability. He had previously visited and carefully studied the chief agricultural academies and schools of Europe, and his idea of what an American agricultural college should be was as definite as it was comprehensive and just. He found the college a struggling institution, its buildings not half finished, and its exchequer awaiting the action of a hesitating legislature for funds to carry on the enterprise. With characteristic energy he organized a new plan of instruction, planned and superintended the erection of the college buildings, secured endowments, and, besides taking the general guidance of the institution, he gave instruction and superintended the practical investigations of the students in chemistry, scientific agriculture, mineralogy, and geology.

He had just succeeded in establishing a thoroughly scientific institution upon a broad and enduring basis, and in convincing a sceptical public of the ultimate success of such a noble enterprise, when death cut short his work. He died in Bellefonte, Pa., on the 29th of

April, 1864, after less than a week's illness, at the age of thirty-six.

C. M. Wetherill, M.D.—Prof. Wetherill's researches, like his lamented and sudden death, are fresh in our memories. His early papers in 1848, in the *Annalen der Chem. und Pharm.*, were "On the Neutral Sulphates of Ethyloxyd, their Decomposition Products with Water" ("Ueber Neutrales Schwefelsaures Æthyloxyd und dessen Zersetzung Stroderete mit Wasser"), and "Analysis of the Subsulphate of Cinchona." The first of these papers is reproduced in the *Proc. Am. Phil. Soc.*, 1848. His last papers are "Experiments with the Ammonium Amalgam" (*Sill. Journ.*, 2, xl. pp. 160–165, 1865), and "On the Existence of the (so-called) Ammonium Amalgams" (*Sill. Journ.*, 3, i. pp. 369, 371, 1871), both of which are most creditable contributions. The first demonstrates that the ammonium amalgam, so called, is a metallic froth; the second that the compound ammonias, *e. g.*, methyl-ammonium-oxalate, may form the so-called amalgam. Dr. Wetherill published a number of other papers, chiefly analyses, *e. g.*, "Concretion from the Stomach of a Horse;" "Molybdate of Lead;" "Food of the Queen Bee;" "Mexican Honey Ant," etc.; "A New Apparatus for the Determination of Carbonic Acid" (May, 1873, *Journ. Frank. Inst.*, xxx. 333). "Examination of Fusel Oil from Indian Corn" (May, 1873, *Journ. Frank. Inst.*, xxx. 385). This is a valuable contribution, with a fractional distillation of the crude oil, an ultimate analysis of the silver salt of one of the fatty acids from the distillate ($C_{16}H_{15}O_4Ag$), and an examination of the alcohol of fusel oil. "Examination of Gas of the Philadelphia Gas Works" (1854, *Journ. Frank. Inst.*, xxviii. 35). "An apparatus for Organic Analysis by Illuminating Gas, and on the use of this Gas in Experimental Analysis" (1854, *Journ. Frank. Inst.*, xxviii. 107–115; 184–191; 274–279). "Description of an Apparatus for Broiling by Gas" (1854, *Journ. Frank. Inst.*, 121). His paper on "Adipocire and its Formation" (*Trans. Am. Philo. Soc.*, xi. 1855) contains the results of both chemical and microscopical examinations of adipocire, with an account of experiments on the decomposition of muscular fibre by water with a view to the formation of adipocire. In 1859 he published "Analysis of the White Sulphur Water of the Artesian well of Lafayette, Indiana" (*Sill. Journ.*, 2, xxvii. pp. 241–249); a carefully conducted investigation of permanent value. "On the Crystallization of Sulphur, and upon the Reaction between Sulphid of Hydrogen, Ammonia, and Alcohol" (*Sill. Journ.*, 2, xl. pp. 338–344); a research undertaken to determine the conditions requisite to produce octohedral and prismatic sulphur. "On the Crystalline Nature of Glass" (*Sill. Journ.*, 2, xli. pp. 16–27). This curious research has demonstrated the fallacy of the common opinion that glass is quite amorphous, and demands further investigation.

"Experiments on Itacolumite (Articulite), with the Explanation of its Flexibility and its Relation to the Formation of the Diamond" (*Sill. Jour.*, 2, xliv. pp. 61–71). This is a most ingenious and suggestive paper, and is an excellent illustration of the skill and ingenuity which the author brought to bear on a seemingly unpromising subject, whether we accept his conclusions or not.

The only volume published by Dr. Wetherill was his technical treatise, called "The Manufacture of Vinegar; its Theory and Practice, with Special Reference to the Quick Process," 1860, pp. 300, which is a very useful book.

There are other names of early laborers in the common field which are not forgotten, but time fails us that we should enumerate all in a summary which does not claim to be complete. The names of Renwick, Chilton, Dewey, T. Dwight Eaton, Elisha Mitchell; Thos. D. Mitchell, Steel, E. Hitchcock, Webster, Hall, Godon, S. G. Morton, Keating, W. R. Johnson, and others, are among the unrecorded ones in our Address.

No definite line of division can be drawn between the two moieties of our century of chemistry. The notice we have taken of those whose names have already been mentioned has, almost unavoidably, been somewhat biographical. For those who are yet in active work this course is, for obvious reasons, undesirable, and our notice of the contributions of living men must generally be much less personal. Before resuming our enumeration of contemporaneous work, it will be proper to touch briefly on some general considerations which naturally suggest themselves in this connection.

It is easy to see, by a review of the ground gone over, that, in the early history of chemistry in the United States, there were a few workers whose labors have made a sensible impression on the history of the science. Such were Rumford, Priestley, Hare, Silliman, Gorham, J. F. Dana, Wells, Bache, Seybert, Bruce, Torrey, Mather, Troost, Bowen, and others. As a department of academic training chemistry was generally provided for in most of the colleges, but it was usually coupled with natural philosophy and natural history, and was never made the subject of personal laboratory training other than by didactic and demonstrative lectures. Practical and analytical laboratories of instruction were unknown. With a few honorable exceptions, the incumbents of professorial chairs made no contributions to the advancement of science, or the stock of human knowledge. Text-books and manuals were supplied, prior to the appearance of those of Gorham and J. F. Dana, by the republication of European manuals, such as those of Henry, Murray, Brande, Chaptal, and the like. The subjects which very naturally occupied the attention of chemists here, as elsewhere, in the early part of this century were largely physical, growing naturally out of the excitement following the discovery of the pile of Volta, and its use by Davy in evolving potassium, sodium, and the other like metals from their combinations.

The "New Chemical Philosophy" of the French school had gradually won its way to complete supremacy over the phlogistic theory, although, as we have seen, Dr. Priestley to the last did battle valiantly for the doctrines of Stahl. But, although Davy's determination of the real nature of chlorine was the *coup de grace* to the old ideas, we still find the literature of chemistry full of desperate struggles to resist the dualistic philosophy which for more than half a century since has, until within the past twenty years, held almost undisputed dominion.

A few American chemists very early sought the advantages offered to students by the School of Mines in Paris—for example, the two Seyberts, Keating, Vanuxem, Clemson, etc., or, like Silliman and Gorham, found guidance in London and Edinburgh. But the advantages thus obtained were neither easy of access, nor otherwise well suited to the wants of students. Private laboratories of eminent chemists were at that time nearly closed to the access of students, few of whom enjoyed such advantages as the brothers Rose found in the laboratory of Berzelius. No chemical schools or laboratories were then organized for chemical training of stu-

dents in the arts of analysis, and the methods of research were unknown, in fact, until Liebig, in 1826, first threw open wide the doors of access to the laboratory at Geissen, and welcomed cordially all students without distinction of nationality to his scientific hospitality. It was there that Hoffmann, Will, and Fresenius were his assistants, and we find the names of Johnston, Lyon Playfair, and Gregory among his English-speaking students before the tide of American followers had set in. This marks an era in the scientific history of the world that made itself felt far and wide, and nowhere more than in the United States, although nearly twenty years later, when it contributed its quota to the events next to be considered.

Great Scientific Awakening about 1845.—The year 1845 marks the beginning of a new era in the scientific life of America, which is still in active progress, and chemistry has had its full share in this advance. Many circumstances conspired to bring about this increased activity, some of which we will briefly enumerate:—

Louis Agassiz arrived in the United States in the autumn of 1846, and commenced his wonderful course of scientific labor which has made itself felt in all departments of research, and has infused a zeal for scientific studies and research in the public mind before unknown. Coming only as a guest, and for a special mission, he found here a home which with joy opened to receive and adopt him as an American citizen, and has made his name a household word in every hamlet of this broad land.

The Smithsonian Institution, founded by an Englishman, was organized at Washington in 1846, and commenced its labors under the guidance of Prof. Joseph Henry in 1847. Opening wider and yet more freely the various paths of scientific research with every passing year, and placing the science-workers of America in intimate fellowship with their co-workers in all parts of the civilized globe, its influence for good is steadily increasing.

The United States Coast Survey had in 1845 just passed under the comprehensive direction of Prof. Alexander Dallas Bache, and was at the commencement of this new epoch in American science already making its power felt in all departments of research: co-ordinating, systematizing, and directing not only its own special methods, but extending its hospitality and encouragement alike to physicists, chemists, naturalists, and explorers—what a power it has ever been in this country for the advancement of science, and what a school for special training, is the cheerful acknowledgment of all who have any knowledge of scientific progress in the United States during the past thirty years.

Astronomical Observatories.—In 1845 Professor Ormsby Macknight Mitchel effected the establishing of the Astronomical Observatory at Cincinnati, since so renowned in astronomical history. Observatories had existed before in the United States at Yale (1830), Williams (1836), Western Reserve (1838), etc., but they were more or less imperfectly organized, and we believe that the efforts of General Mitchel at Cincinnati may be fairly looked upon as the starting point of that great activity in astronomy in this country, which has since developed itself, and has so unexpectedly, by aid of the spectroscope, connected astronomy and chemistry so intimately as to render them in some sense co-ordinated sciences.

The American Association for the Advancement of Science commenced its enlarged existence in 1848, being evolved out of the Association of American Geologists and Naturalists, which body at its last meeting in Boston, in 1847, resolved to enlarge its sphere of action, to include physics, chemistry, astronomy, and the allied physical sciences. This latter organization has itself been an outgrowth from an earlier organization, the American Association of Geologists, founded originally by the joint action of those who, in 1840, were charged with the conduct of the geological surveys of the States then prosecuting such explorations. The *Proceedings* of the American Association for the Advancement of Science at once opened a new channel of communication for the workers in science, while the migrations of the association tended doubtless to quicken the public interest in scientific pursuits.

The American Philosophical Society had a little earlier, in 1843, held its centennial celebration in Philadelphia, an event which stimulated to renewed activity the oldest of American scientific societies, and drew together a large number of co-workers from distant places to participate in this scientific festival. It was fit that the oldest scientific organization in this country, with a noble record of work in the first quarter of our chemical century, should join with fresh vigor in the great awakening which has distinguished the latter quarter of the same century.

The American Journal of Science closed its first half century of volumes in 1845, and commenced its second series in the year 1846 under an enlarged editorial management, and with more frequent issues, thus offering to investigators more frequent contact with their fellow-workers.

The year 1847 witnessed also the inauguration of the system of schools for science training in some of the older colleges, which has since led the way to the establishing of like schools far and wide.

At Yale College in 1847 was instituted the "Department of Philosophy and the Arts," and work was commenced under it in the "Yale Analytical Laboratory" under the instruction of Professors Norton and Silliman, Jr. This effort was almost without any endowments in money, and was carried on for some years exclusively at the personal charge of the two professors, who not only paid their own salary, but furnished the laboratories, library, apparatus, and collections, and even paid a rent to the academical department for the use of the old presidential house, which they had also paid for fitting up for the use of the school. From the very commencement of this work by Professor Silliman, Jr., some four or five years before, in a small way, evidence was not wanting in the gathering of pupils of the existing necessity for such instruction.

At Harvard in the same year Mr. Abbott Lawrence had just made an endowment of fifty thousand dollars, at that time of unparalleled munificence, which became at once the starting point of the "Lawrence Scientific School" under the direction of Professor E. N. Horsford, who had then but recently returned from the instructions of Liebig. How suggestive, and fruitful in noble emulation, this good example of Lawrence has been in the scientific endowments of seats of learning, we may see on every hand. It is only necessary to mention the names of Sheffield, of Peabody, of Williston, of Hopkins, of Chandler, of Judd, of Packer, of Pardee, of Edwin A. Stevens; the endowments of Agassiz's Museum of Comparative Zoology of the Harvard Observatory, of the Winchester Observatory at Yale, and, lastly, of the more than regal munificence to science by the gifts of James Lick upon the Pacific coast, and of others

which might properly be mentioned—to see at once the cause and effect of our increased activity in all departments of scientific research.

But this is not all.

The conquest of Mexico by the United States in 1845, the acquisition of California, and the subsequent discovery of its gold and of the gold of Australia, are events which have most obviously added their powerful stimulus to the general activity of the entire country, and, we may add, of the world, awakening the public mind to the importance of physical studies, and aiding to give them a rank in the general estimate they had never before attained, whether as means of intellectual and general culture, or as ends for the attainment of wealth and power. Without the almost convulsive shock thus imparted to the old-time system of education, by the union and focalization of all these and other like causes, the inertia with which the arguments for a more comprehensive training in our institutions of learning were so long successfully resisted, would still continue, and the "humanities" of mediæval scholasticism would have never relaxed their almost exclusive dominion in a polite education. That we are here to-day as chemists, and to celebrate this new Atlantis "for the glory of the Creator and the relief of man's estate," is in testimony that a great advance has been made upon the old traditions—a victory achieved, and with a yet more fruitful future before us and those who are to follow.

Thus on every hand, under the inspiration of these combined influences, and others of a like nature not so conspicuous, was the educated mind of America directed with new intent toward all departments of scientific study, and a revival of learning followed, which happily is still in full progress. The work in the various geological and other explorations already undertaken, or, like the Wilkes expedition, just completed, had, in 1845, furnished a small band of picked men trained for original research. Chemical students, drawn to Europe by the attraction of the writings of Liebig and the laboratory training of Wöhler and others were returning to infuse new activity and accuracy into chemical studies, establishing laboratories for research in various departments of original investigation.

There had, indeed, been a partial kindling of a like nature twenty-five or thirty years before, when the early munificence of William Maclure aroused in Philadelphia and New Haven, and to some extent in other cities, a remarkable zeal for the study of geology, mineralogy, and general natural history, followed by the publication of his geological map of the United States, by the establishing of the "Academy of Natural Sciences" in Philadelphia, the "Lyceum of Natural History" in New York, and the "American Geological Society" in New Haven. But the failure of Mr. Owens's educational scheme at New Harmony, where Mr. Maclure had made a heavy investment, and had carried an important part of his collection of books and natural history specimens, accompanied by Say, Leseur, and others, ending in his removal to Mexico, where his delicate health compelled him to reside, led the way to a considerable suspension of this new activity in science. Nearly all the publishing societies in America became dormant, or languished with intervals of spasmodic activity. Some of them died entirely. *Bruce's Journal* died, and a period of general stagnation in scientific activity prevailed for some years. This gradually yielded to better influences. Chemistry was making slow but steady progress. Evidence of original work began to appear in this and the cognate sciences, as will be seen by what has already been recorded, and thus the way was opened for the entrance of those combined influences which developed themselves, as we have just specified, about the years 1845–47, under circumstances so auspicious.

[In the following enumeration of clinical contributions by authors now living, an effort has been made, as far as practicable, to preserve a chronological order; but this could not be very strictly observed. It was at first intended to classify the contributions to chemistry in this country subjectively; but this was found to be inconsistent with the effort to do each worker the fairest amount of justice possible. Nor has it been thought essential to preserve a strict order in the mode of enumerating papers. The author has desired to make this list as complete as possible, but he is sensible of its imperfections, while he is at the same time unconscious of any intentional omissions, and hopes for a friendly indulgence where omissions exist. To those who have kindly responded to his request for assistance in preparing the lists which follow, he returns his thanks, and he takes this occasion to remind others if they find their lists incomplete, that they have had an opportunity to make them otherwise.]

Joseph Henry, Washington, D. C.—Professor Henry, now the Nestor of American science, has devoted his great powers, during a long and active life, chiefly to other branches of science and administrative duty, and with what eminent success need not be recounted here. But we find him early in his scientific studies at work in the laboratory of Dr. T. R. Beck, in Albany, and afterwards, in the absence of Dr. John Torrey, delivering the chemical lectures at Nassau Hall, in Princeton. While in Albany with Dr. Beck, he devised and published an improved form of Wollaston's sliding scale of chemical equivalents, in which hydrogen was adopted as the radix, a contrivance which is hardly known, even by name, to the present generation of chemists.

Prof. Henry, in the discharge of his duties as the Secretary of the Smithsonian Institution, has had it in his power greatly to advance chemical science, both by encouraging original researches in the laboratory of the institution and elsewhere, and also in his Annual Reports and in the Smithsonian Contributions and Miscellaneous Collections, by publishing chemical memoirs by American chemists, and promulgating a knowledge of those undertaken, either by encouragement of the Smithsonian, or elsewhere.

By his own original researches in electro-magnetism, commenced in Albany in 1826, and continued at Princeton after his removal to Nassau Hall, Prof. Henry has contributed more than any other American to the advancement of that important department of physics, which has been so fruitful in the hands of inventors in new and important practical applications closely affiliated to chemistry.

Prof. Henry's original contributions to science have been chiefly physical, but they fall largely into the department of chemical physics.

The following is a brief enumeration of his scientific investigations and discoveries:—

1. A sketch of the topography of the State of New York, embodying the results of the survey before mentioned.

2. In connection with Dr. Beck and the Hon. Simeon De Witt, the organization of the meteorological system of the State of New York.

3. The development, for the first time, of magnetic power, sufficient to sustain tons in weight, in soft iron, by a comparatively feeble galvanic current.

4. The first application of electro-magnetism as a power, to produce continued motion in a machine.

5. An exposition of the method by which electro-magnetism might be employed in transmitting power to a distance, and the demonstration of the practicability of an electro-magnetic telegraph, which, without these discoveries, was impossible.

6. The discovery of the induction of an electrical current in a long wire upon itself, or the means of increasing the intensity of a current by the use of a spiral conductor.

7. The method of inducing a current of quantity from one of intensity, and *vice versa*.

8. The discovery of currents of induction of different orders, and of the neutralization of the induction by the interposition of plates of metal.

9. The discovery that the discharge of a Leyden jar consists of a series of oscillations backwards and forwards until equilibrium is restored.

10. The induction of a current of electricity from lightning at a great distance, and proof that the discharge from a thunder cloud also consists of a series of oscillations.

11. The oscillating condition of a lightning-rod while transmitting a discharge of electricity from the clouds, causing it, though in perfect connection with the earth, to emit sparks of sufficient intensity to ignite combustible substances.

12. Investigations on molecular attraction, as exhibited in liquids, and in yielding and rigid solids, and an exposition of the theory of soap bubbles. [These originated from his being called upon to investigate the causes of the bursting of the great gun on the United States Steamer Princeton.]

13. Original experiments on and exposition of the principles of acoustics, as applied to churches and other public buildings.

14. Experiments on various instruments to be used as fog signals.

15. A series of experiments on various illuminating materials for light-house use, and the introduction of lard oil for lighting the coasts of the United States. This and the preceding in his office of Chairman of the Committee on Experiments of the Light-House Board.

16. Experiments on heat, in which the radiation from clouds and animals in distant fields was indicated by the thermo-electrical apparatus applied to a reflecting telescope.

17. Observations on the comparative temperature of the sun-spots, and also of different portions of the sun's disk. In these experiments he was assisted by Professor Alexander.

18. Proof that the radiant heat from a feebly luminous flame is also feeble, and that the increase of radiant light, by the introduction of a solid substance into the flame of the compound blowpipe, is accompanied with an equivalent radiation of heat, and also that the increase of light and radiant heat in a flame of hydrogen, by the introduction of a solid substance, is attended with a diminution in the heating power of the flame itself.

19. The reflection of heat from concave mirrors of ice, and its application to the source of the heat derived from the moon.

20. Observations, in connection with Professor Alexander, on the red flames on the border of the sun, as observed in the annular eclipse of 1838.

21. Experiments on the phosphorogenic ray of the sun, from which it is shown that this emanation is polarizable and refrangible, according to the same laws which govern light.

22. On the penetration of the more fusible metals into those less readily melted, while in a solid state.

Besides these experimental additions to physical science, Professor Henry is the author of twenty-five [1846–71] reports, giving an exposition of the annual operations of the Smithsonian Institution. He has also published a series of essays on meteorology in the Patent Office Reports, which, besides an exposition of established principles, contain many new suggestions; and, among others, the origin of the development of electricity, as exhibited in the thunder-storm; and an essay on the principal source of the power which does the work of developing the plant in the bud, and the animal in the egg.

He has also published a theory of elementary education, in his address as President of the American Association for the Advancement of Education, the principle of which is, that in instruction the order of nature should be followed; that we should begin with the concrete and end with the abstract, the one gradually shading into the other; also the importance of early impressions, and the tendency in old age to relapse into the vices of early youth. Youth is the father of old age rather than of manhood.

He was successful as a teacher, and never failed to impart to his students a portion of his own enthusiasm. His object was not merely to impart a knowledge of facts, but mainly to give clear expositions of principles; to teach the use of generalizations, the method of arriving at laws by the process of induction, and the inference from these of facts by logical deduction.

Henry Seybert, of Philadelphia, like his father, Adam Seybert, was educated in the School of Mines in Paris, and was an early contributor to our knowledge of the chemical constitution of American minerals. In 1822 he analyzed the sulphuret of molybdenum from Chester, Pa.; chromate of iron from Maryland and Pennsylvania; the tabular spar, pyroxene, and colophonite of Willsborough, N. Y., and the maclureite (chondrodite) of New Jersey (in which he independently discovered fluorine as Dr. Langstaff had done before). He also analyzed the manganesian garnet found with the chrysoberyl at Haddam, Conn., and the chrysoberyl of the same locality. In 1830 he analyzed the Tennessee meteorite of Bowen, since which date I have been unable to find any further contributions from Mr. Seybert, whose attention was unfortunately diverted from science, to which his early life was so advantageously devoted, to other and less fruitful lines of investigation.

Charles Upham Shepard, M.D., New Haven.—From the year 1824 to this time Prof. Shepard's name has been intimately associated with the progress of American mineralogy and the study of aerolites. His chemical work has been largely given to the examination of meteoric masses, to which he has devoted special attention, amassing probably the finest collection of these remarkable bodies which exists in America. Nearly all his papers on mineralogy and meteorites have appeared in the *American Journal of Science* and in the Proceedings of the American Association for the Advancement of Science, and for a full list of titles reference may be had to these works. The catalogue of the Royal Society contains, prior to 1863, titles of seventy-eight papers by Prof. Shepard. In 1832 he

published his "Treatise on Mineralogy," based on the natural system of Mohs, and subsequent editions have appeared in 1844, 1852, and 1857.

No observation or original research of Dr. Shepard has been fruitful of so much good in its consequences as his discovery, about 25 years ago, of the deposit of phosphate of lime in the Eocene marl of South Carolina, and the distinct recognition of the fact of its great value for agriculture. This discovery led, in 1859–60, to finding, in the immediate vicinity of Charleston, the richest phosphates directly above and upon the Eocene, and to its introduction into commerce on a vast scale, and the manufacture of superphosphate fertilizers, not alone for this country, but for foreign export, and the growth in consequence of an important industry in the chemical arts at Charleston.

Augustus A. Hayes, Brookline, near Boston, Mass.—Dr. Hayes has been an industrious worker in chemistry from an early date until the failure of his health some ten years since. His papers are scattered over a wide range, and the following is only a partial list:—

1831. Production of Hydrocyanic Acid under unusual circumstances. *Journ. Royal Inst.*, i. 169.

1848. Native Copper from Lake Superior. *Am. Acad. Proc.*, ii. 195.

1848. On the Urinary Deposit called Red Sand. *Ibid.*, 196.

1848. On Stereopene, or Camphor from Crude Oil of Valerian. *Ibid.*, iii. 99–100.

1850. On the Assumed Existence of Ammonia in the General Atmosphere. *Proc. Am. Ass.*, iv. 207–213.

1852. On a New Species of Wax. *Am. Acad. Proc.*, iii. 190.

1852. On Native Iron from Siberia. *Ibid.*, iii. 149.

1852. On Aluminium. *Ibid.*

1852. Bessemer Process; New Points of Chemical Interest. *Ibid.*, iii. 322.

1852. Fossilized Egg from the Guano Island. *Proc. Boston Nat. Hist. Soc.*, v. 165.

1852. On Cochituate Water. *Ibid.*, 169.

1852. Analysis of a Saline Mineral from South America. *Ibid.*, v. 192–390.

1852. On the State in which Phosphate of Lime Exists in Sea-Water. *Ibid.*, vi. 48.

1852. Analysis of a Specimen of Gum from Africa. *Ibid.*, vi. 129.

1852. On a kind of Sugar developed in Sorghum. *Ibid.*, 200–203, 207–209.

1852. On some Modified Results attending the Decomposition of Bituminous Coals by Heat. *Ibid.*, vii. 50–51; also, in *Am Journ. Sci.*

1857. On the Composition of the so-called Guano of the Atlantic Islands. *Edinb. N. Phil. Journ.*, ii. 107.

1857. Corrosion of Yellow Metal. *Am. Acad. Proc.*, iv. 28.

1857. Chemical Examination of a Substance found in the Medullary Cavity of Trees in the Sandwich Islands. *Proc. Boston Soc. Nat. Hist.*, vii. 209.

1861. On the Occurrence of Soluble Compounds of Copper, Lead, and Zinc in Alcohol. *Lond. Chem. News*, iv. 117.

1870. On the Cause of the Color of the Water of Lake Leman, Geneva. *Am. Journ. Sci.* [2], xlx. 186.

1872. On the Red Oxide of Zinc of New Jersey. *Ibid.* [3], iv. 191.

Lewis Feuchtwanger, M.D., New York.—Dr. Feuchtwanger has been known to American chemists by his commercial establishment for the manufacture and sale of rare chemicals for over forty years. He has also added something to our literature.

1831. Remarks on Arsenic, with Drawings of the Color of its Precipitates formed by Reagents applied to them. *Sill. Journ.*, xix. 339, with a colored plate.

1837. Expeditious Mode of Manufacturing Vinegar. *Ib.*, xxxi. 272.

1867. A Popular Treatise on Gems, 12mo. pp. 505, and a new edition in 1872.

1872. Remarks on Glass Making. *Proc. Am. Ass.*, xxii. 88.

Robert Peter, M.D., Professor of Chemistry in the University of Transylvania, Lexington, Ky.—Dr. Peter, who is one of the oldest chemists in the United States, has been connected with the geological surveys of Kentucky and Indiana, as well as with various institutions of learning. His published papers are in part as follows:—

1834. Thoughts on the Application of Chemistry to Medicine. *Transyl. Med. Journ.*, vol. vii.

1834. An Account of the Vegetable Alkalies, including their Therapeutic Action when applied internally or by the Endermic Method. *Ibid.*

1835. Notice of the Crab Orchard Mineral Springs (Lincoln County, Ky.), with a Chemical Analysis of Four of the Waters. *Ibid.*, vol. viii.

1846. Chemical Analysis of Urinary Calculi in the Museum of the Medical Department of Transylvania University, with Remarks on the Relative Frequency of Calculi in Lexington, Ky., and the Probable Causes. *Western Lancet*, vol. v.

This paper was subsequently reproduced with thirty-four additional pages, and several new analyses in the *Transylvania Med. Journ.*, N. S.

1849. Remarks on the Agriculture of the Blue Limestone of Kentucky, with its Analysis. *Albany Cultivator*, Albany, N. Y., vol. v.

1849. On Ozone. } In the *Trans. Med. Journ.*, vol. i., N. S.
On Magnesia as an Antidote to Arsenic. }

1850. The Quantitative Analysis of the Water of the Lower Blue Lick Spring, in Nicholas Co., Ky., with remarks on some other Salt Springs of the Blue Limestone Formation. *Quar. Med. Journ.*, Lexington.

1852. A series of lectures (contributed to same Journal) on the Chemical Relations of Organic Bodies, and on the Chemistry of the Urine.

1856. Chemical Analysis of Soils, Minerals, Rocks, Ores, Coals, Waters, etc. etc., with remarks covering 124 pages of vol. i. of the Reports on the Kentucky Geological Survey. 8vo.

1857. To vol. ii. of same Report, 184 pages containing the account of 206 chemical analyses contributed to the work by Dr. Peter.

1857. To vol. iii. of same report, Dr. Peter contributed 247 pages, and 220 chemical analyses with remarks.

1861. To vol. iv. of same report, he contributed 291 pages, with 529 chemical analyses, etc.

1860. In the Second Report of a Geological Reconnoissance of the Southern and Middle Counties of Arkansas, made during the years 1859–60, by Dr. David Dale Owen, Geologist (Phila., 8vo. pp. 433), etc., Dr. Peter, as the chemist to the survey, contributed an account of 271 chemical analyses by himself of the soils, subsoils, under-clays, nitre-earths, etc., of Arkansas, with remarks covering 125 pages.

1860. In Report of a Geological Reconnoissance of Indiana by Dr. D. D. Owen, made during 1859–60, Dr. Peter contributed the chemical analyses of thirty-three soils, subsoils, etc. Indianapolis, 1862, pp. 368, 8vo.

1873. Dr. Peter adds to his former chemical work on the Geological Survey of Kentucky (Prof. N. S. Shaler Chief Geologist), a new chapter in the report now about to be published.

John William Draper, Prof. of Chemistry New York University, New York.—Few men of science now living in America have been so long and so favorably known in the various departments of scientific investigation, which he has followed, as Dr. Draper. His reputation is cosmopolitan, and many of his publications have been reproduced in several European languages. The following is believed to be a full list of Dr. Draper's scientific papers, arranged in chronological order. Many of them are not, properly speaking, chemical, but belong rather to the department of molecular physics.

1834. "On Capillary Attraction," showing that it is an electrical phenomenon, and containing an explanation of endosmosis, *Journ. Frank. Inst.*, Sept., 147.

1834. "Analysis of Native Chloride of Carbon," *Journ. Frank. Inst.*, Nov., 295.

1834. "On a Galvanic Battery of Four Elements," *Journ. Frank. Inst.*, Nov., 289. It contains the voltaic decomposition of fused salts, and reducing effect of liberated hydrogen.

1835. "Experiments to determine whether Light has any Magnetic Action," *Journ. Frank. Inst.*, Feb.

1836. "Experiments on the Tidal Motions of Conductors Free to Move," being an investigation of the figure of equilibrium, and the motions of masses of mercury under the influence of a voltaic current, *Frank. Inst. Journ.*, January.

1836. "Analysis of some Ancient Coins," *Silliman's Amer. Journ.*, vol. xxix., 157.

1836. "Experiments on Endosmosis," *Frank. Inst. Journ.*, March.

1836. "Endosmosis through Water Strata and Soap Bubbles," *Frank. Inst. Journ.*, July.

1836. "On Interstitial Movements," *Amer. Journ. Med. Sci.*, May.

1836. "Observations on Microscopic Chemistry," *Journ. Frank. Inst.*, Dec.

1837. "Experiments on Solar Light," *Frank. Inst. Journ.*, June, July, Aug., Oct. These contain, among many other things, experiments on the absorption of the chemical rays, decomposition of carbonic acid by light, diffraction of the chemical rays, deposition of camphor crystals, and effects of light on vegetation.

1838. "On the Physical Theory of Capillary Attraction," *Amer. Journ. Med. Sci.*, Feb.

1838. "On the Great Mechanical Force Generated by the Condensing Action of Tissues," showing that gases will diffuse into each other against the pressure of many atmospheres and the voltaic decomposition of water under heavy pressures, *Amer. Journ. Med. Sci.*, May.

1838. "On the Physical Theory of Endosmosis," *Amer. Journ. Med. Sci.*, Aug.

1838. "On the Constitution of the Atmosphere," *Lond. Phil. Mag.*, Oct.

1839. "On the Measurement of the Tension of Electrical Currents," *Phil. Mag.*, Oct., Nov.

1840. "Some Experiments on the Sun's Light, made in the South of Virginia," *Phil. Mag.*, Feb.

1840. "On the Electromotive Power of Heat," containing a description of improved thermo-electrical couples, *Phil. Mag.*, June.

1840. "On the Taking of Portraits from the Life by the Daguerreotype," *Phil. Mag.*, Sept. This memoir contains the first description published on photographic portraiture.

1841. "On some Analogies between the Chemical Rays and Radiant Heat," *Phil. Mag.*, Sept.

1842. "On a New Imponderable Principle," *Phil. Mag.*, Dec.

1843. "On Certain Spectral Appearances connected with Photography, and on Latent Light,' *Silliman's Journal*, vol. xliv.

1843. "On the Law of the Conducting Power of Wires for Electrical Currents," an investigation connected with Morse's invention of the telegraph, *Silliman's Journal*, vol. xlv.

1843. "Photographic Copies of the Fixed Lines of the Spectrum." This memoir contains the description of many new lines, both in the ultra red and ultra violet spaces. *Phil. Mag.*, May.

1843. "On the Decomposition of Carbonic Acid by Plants in the Prismatic Spectrum." Up to this time it was supposed that the deoxidation of carbonic acid is accomplished by the violet rays; this memoir showed that it is by the yellow rays. *Silliman's Journal*, vol. xlvi., *Phil. Mag.*, Sept.

1843. "On a Change Impressed by Light in the Properties of an Elementary Substance," *Phil. Mag.*, Nov.

1843. "Description of the Chlorine and Hydrogen Photometer (Tithonometer)," an instrument subsequently used extensively by Bunsen and Roscoe in their photo-chemical researches. *Silliman's Journal*, vol. xlvi., *Phil. Mag.*, Dec.

1844. "On Tithonized Chlorine," *Phil. Mag.*, July.

1844. "On a Fourth Imponderable," *Phil. Mag.*, Aug.

1845. "On Capillary Attraction," *Phil. Mag.*, March.

1845. "On the Interference or Diffraction Spectrum," *Phil. Mag.*, June.

1845. "On the Allotropism of Chlorine as Connected with the Theory of Substitutions," *Silliman's Journal*, vol. xlix.

1845. "On the Light of Ignited Lime and the Electric Spark," *Phil. Mag.*, Dec.

1846. "On the Circulation of the Blood as depending on Chemical Action," *Silliman's Journal*, 2d series, vol. ii.

1847. "On the Negative or Protecting Rays of the Spectrum," *Phil. Mag.*, Feb.

1847. "On the Production of Light by Heat." This memoir contained many facts published subsequently (1860) without due acknowledgment by M. Kirchoff in his celebrated memoir as mathematical deductions. *Silliman's Journal*, 2d series, vol. iv., *Phil. Mag.*, May.

1848. "On the Production of Light by Chemical Action," *Silliman's Journal*, 2d series, vol. v., *Phil. Mag.*, Feb.

1849. "On the Allotropism of Living Beings," *Phil. Mag.*, April.

1851. "On Phosphorescence," *Phil. Mag.*, Feb.

1851. "On the Chemical Action of Light," *Phil. Mag.*, May.

1853. "On a New Method for the Quantitative Estimation of Urea," *Phil. Mag.*, Oct.

1857. "On the Diffraction Spectrum," *Phil. Mag.*, March.

1857. "On Photometry," *Phil. Mag.*, Sept.

1857. "On the Modification of Chlorine," *Phil. Mag.*, Nov.

1858. "On the Nature of Flame and Condition of

the Sun's Surface," *Silliman's Journal*, 2d series, vol. xxvi., *Phil. Mag.*, Feb.

1872. "On the Distribution of Heat in the Spectrum," *Silliman's Journal*, 3d series, vol. civ., 161.

1873. "On the Distribution of Chemical Force in Spectrum," *Silliman's Journal*, 3d series, vol. cv., 25, 91.

Besides these he published in 1844 a volume entitled "A Treatise on the Forces which Produce the Organization of Plants." In this were collected many of his memoirs on photo-chemical and other subjects, and among them:—

"On the Influence of Physical Agents on Organization and Life."

"On the Action of the Sunbeams in Producing Organized Bodies."

"On the Mechanical Cause of the Flow of Sap in Plants—it is due to the Carbonization of Water on the Leaves by the Light of the Sun."

"On the Physical Constitution of the Sunbeam, and on the Prismatic Spectrum."

"On the Diffraction Spectrum" (with a colored plate).

"Experiments proving that it is in the Yellow Region of the Spectrum that Reduction of Carbonic Acid by the Leaves of Plants takes place."

"On the Theory of Ideal or Imaginary Coloration."

Many of the above memoirs have been translated into French, German, Italian, and republished in various European journals.

In 1856 Dr. Draper published a Treatise on Human Physiology, containing, in like manner, the solution of many chemico-physiological and physical questions respecting digestion, absorption, the flow of the chyle and lymph in their special vessels, the mechanical action of the heart, the dependence of circulation on respiration, the nature of nervous action, the functions of the different portions of the ear, the tympanum, cochlea, semicircular canals; the nature of vision, and explanation of the functions of different portions of the eye; the influence of physical agents on the organic series. This work has been translated into Russian, and is largely used in the schools of that country.

It may be added that Dr. Draper took the first photographic portrait of the human face, and thereby laid the foundation of what has since become an important branch of industry; the first photograph of the moon; the first photograph of the diffraction spectrum. Simultaneously with Becquerel, he photographed the Fraunhofer fixed lines of the spectrum, and the ultra violet ones, and was the first to discover the great bands in the ultra red region.

In the midst of so much scientific activity, Dr. Draper has found time for relaxation in purely literary pursuits. He has published historical works on the Intellectual Development of Europe, and on the American Civil War, which have been translated into almost every European language; but these are sujects outside of the present memoir.

Rogers.—There have been five persons of this name in the United States who have been more or less intimately connected with the history of the science by their contributions and labors. They are all of one family, the father and four sons, whose names are familiar the world over. The father—

Dr. P. K. Rogers was the Professor of Natural Philosophy and Chemistry at the College of William and Mary in Virginia, from 1819 to 1829. If Dr. Rogers had made no other contribution to the progress of chemistry in the United States than to have trained four sons to the pursuits of science, he has left record which is probably without a parallel. But we know that he was an able and faithful teacher of the science, and his labors live in the lives of his pupils.

Wm. B. Rogers, so well known in many departments of scientific research in this country, succeeded his father in the same chair at William and Mary, where he remained until his transfer to the University of Virginia at Charlottesville, in 1836. His scientific labors have been largely geological and physical, but he has also conducted many chemical researches, both alone and in connection with his brothers Robert E. and Henry D. Rogers. We note the following researches by himself alone:—

"On the Existence of Bi-malate of Lime in the Berries of the Sumac (*Rhus glabrum* and *R. Copallinum*) and the Mode of Procuring it from them in the Crystalline Form." (*Am. Journ. Sci.*, xxvii., 1835, pp. 294–299.)

"Apparatus for Analyzing Marl and other Carbonates," and "Self-filling Syphon for Chemical Analysis." (*Am. Jour. Sci.*, xxvii. 299–303.)

"Analysis of (recent) Shells." (1834, *Am. Jour. Sci.*, xxvi. 361.)

"On the connection of Thermal Springs, in Virginia, with Anticlinal Axes and Faults." (1843, *Reports Am. Asso. Geol. and Nat.*, pp. 323–347.) In this important memoir Prof. Rogers gives in a tabular form the results of his Analysis of twenty-eight of the Virginia thermals, and points out particularly the preponderance of free nitrogen among the gaseous contents, much exceeding the CO_2 and H_2S in volume. This paper contains but a small part of the chemical work of the years when, as geologist of Virginia, Prof. Rogers was engaged in an examination of the thermal waters of that vast State. Unfortunately for science the arrest of that work has kept the full results of Prof. Rogers' labors from seeing the light.

"On Ozone Observations" (1858, *Edinb. N. Phil. Jour.*, vii. 35–42). The experiments detailed in the treatise confirm the observations of M. Cloez (*Ann. de Chem.*, 1857, l. pp. 80–96), showing that the effects supposed to be due to ozonized oxygen evolved from growing plants are really due to sunlight and moisture.

"An account of Apparatus and Processes for the Chemical and Photometrical Testing of Illuminating Gas." (*Brit. Asso. Report*, 1864, ii. p. 39.)

Many minor papers by Prof. R. will be found in the *Journ. of the Franklin Inst.*, *Proceed. Am. Phil. Soc.*, of the *Am. Acad.*, and *Am. Ass.*

W. B. Rogers and Robert E. Rogers.—These chemists have together published a number of important chemical contributions, relating chiefly to new or improved methods in chemical analysis and research. Such is their

"New Process for Obtaining Pure Chlorine." (*Sill. Jour.*, 2, i. 428, 1840.)

"On a New Process for obtaining Formic Acid, and on the Preparation of Aldehyd and Acetic Acid by the Use of Bichromate of Potassa." (*Sill. Jour.*, 2, ii. pp. 18–24.)

"On the Absorption of Carbonic Acid by Liquids." Part I. (*Sill. Journ.*, 2, vi. pp. 96–109.) Part II. is in *Proc. Am. Ass.*, 1850, pp. 298–311.

"Oxydation of the Diamond in the Liquid Way." (*Proc. Am. Asso.*, vi. 110.)

"On the Decomposition of Rocks by Meteoric

Waters." (*Proc. Am. Ass.*, 1848, p. 60; *Sill. Journ.*, 2, v. 401.)

"On the Volatility of Potassa and Soda and their Carbonates." (*Proc. Am. Ass.*, 1848, pp. 36–38.)

"On the Use of Hydrogen Gas and Carbonic Acid Gas, to Displace Sulphuretted Hydrogen in the Analysis of Mineral Water," etc. (*Sill. Jour.*, 2, xviii. 213–216, 1854.)

"On a New Method of Determining Carbon in Graphite." (*Sill. Journ.*, 2, v. 352.) This process turns out to be one of the best methods known of determining carbon in the analysis of cast-iron, and is now in constant use in many laboratories for this purpose.

"On the Oxydation of the Diamond in the Liquid Way." (*Sill. Journ.*, 2, vi. 110.) Chromic acid is the agent used.

"On New Instruments and Processes for the Analysis of the Carbonates." (*Sill. Journ.*, 1, xlvi. 346–359.)

Robert E. Rogers and M. H. Boyé.—"On the Analysis of Limestone, especially of the Magnesian kind, and a method of completely separating limes from Magnesia, where both are present in large quantity." (*Frank. Inst. Journ.*, 1840. xxv. pp. 158–162.)

Robert E. Rogers and James B. Rogers.—"On the Alleged Insolubility of Copper in Hydrochloric Acid, and on Fuch's Method of Analyzing Iron Ores." (*Sill. Journ.*, 2, vi. pp. 395 (abstract), and *Am. Asso. Proc.*, Philadelphia, 1848.

Henry D. Rogers wrote chiefly on geology, to which science his contributions are among the most important made in the United States. The joint memoir by himself and Wm. B. Rogers on the structure of the Appalachian, presented at the Boston Meeting of the American Association of Geologists and Naturalists in 1843 (*Trans.*, pp. 474–532), is too well known to require comment from us.

In connection with his brother, W. B. Rogers, Prof. H. D. Rogers in 1835 communicated an important chemico-physical paper entitled "Experimental Inquiry into some of the Laws of the Elementary Voltaic Battery." (*Sill. Journ.*, 1, xxvii. pp. 39–61.)

Some years before his death (in May, 1868) Prof. H. D. Rogers removed to Scotland, where, in 1857, he assumed the duties of the chair of geology and natural history. His enduring monument as a man of science is found in the "Report on the Geology of Pennsylvania." (3 vols. 4to. and atlas.)

It will never be forgotten that the Massachusetts Institute of Technology owes its conception and successful inauguration among the science-teaching institutions of America almost solely to the personal efforts of Prof. Wm. B. Rogers, who presided over its councils until compelled a few years since by failing health to resign its arduous duties.

John Johnston, Professor of Chemistry at Wesleyan University, Middletown, Connecticut, has published the following articles in the *American Journal of Science*:—

1836. [1] Vol. xxx. p. 387. Description of a large Crystal of Columbite.

1839. [1] Vol. xxxviii. 297. Description of Apparatus for preparing liquid and solid CO_2.

1838. [1] Vol. xxxiv. 86. Description of a peculiar Air-pump.

1841. [1] xl. 41. Description of Precious Beryl.

1864. [11] xxxvii. 115. Electric Properties of Pyroxilin Paper.

Prof. Johnston has also published:—

1840. Text-book of Chemistry; on the Basis of Dr. Turner's Elements of Chemistry. This has been revised three or four times in as many new editions.

Elements of Chemistry; an abridgment of the foregoing.

James C. Booth, Ph.D., Philadelphia.—Dr. Booth has contributed the following papers which we have found, and probably others of which I have no notice.

1836. On the Deutarseniuret of Nickel, from Riechelsdorf in Hessia. *Sill. Journ.* [1], xxix. 241.

1841. Analysis of Various Ores of Lead, Silver, Copper, Zinc, Iron, etc., from King's Mine, Davidson County, North Carolina. *Ibid.* [1], xli. 348.

1842. On Beet Root Sugar. *Journ. Frank. Inst.*, and Sturgeon, *Ann. Elect.*, v. 388.

1842. Chrome Iron Analysis. *Ibid.*

1848. Constitution of Glycerine and Oily Acids. *Journ. Frank. Inst.*, xx. 365.

1852. On Remingtonite, a New Cobalt Mineral. *Sill. Journ.* [2], xiv. 38.

In joint authorship with Martin H. Boyé.

1842. Analysis of Well Water in Philadelphia. *Journ. Frank. Inst.* [3], iii. 249.

1842. On the Extraction and Decolorization of Gelatine. *Ibid.*, May, 1842.

1842. On the Preparation of Aluminous Mordants. *Ibid.*

1843. Conversion of Benzoic Acid into Hippuric Acid. *Am. Phil. Soc. Proc.*, iii. 129.

1844. Analysis of Three Kinds of Feldspar. *Ibid.*, ii. 53.

In joint authorship with T. H. Garrett:—

1862. Experiments on Illumination with Mineral Oils. *Journ. Frank. Inst.*, xxv. 193.

In joint authorship with C. Morfitt.

1853. On the Analysis of Cast Iron. *Ibid.* [3], xxv. 193, 247, 317.

1862. Recent Improvements in the Chemical Arts. *Smithsonian Miscellaneous Collections.*

In joint editorship with Martin H. Boyé.

1844. The Encyclopedia of Chemistry. Phila., 8vo.

Report on the Geology of Delaware with Chemical Notes. 8vo.

Charles T. Jackson, Boston.—Dr. Jackson was one of the earliest chemists in the United States to open a laboratory (1838) for instruction and research in analytical chemistry in Boston, where several of the active men of our time obtained their first lessons in the art of chemical analysis. Most of Dr. Jackson's contributions to chemistry have been made in connection with the work of the Geological Surveys of which he had charge, as those of Rhode Island, Maine, New Hampshire, Lake Superior, etc. His memoir, in connection with Francis Alger, on the Geology and Mineralogy of Nova Scotia was an important contribution to science, and gave us our first exact knowledge of that interesting region. He has been recognized and decorated by many European governments as the discoverer of the anæsthetic powers of ether. His alcohol blast-lamp for alkaline fusions of silicates was a powerful heating apparatus which, before the introduction of street gas into laboratory use, was a familiar instrument in most analytical laboratories in America. In the Royal Society Catalogue there are sixty-nine titles under Dr. Jackson's name of papers prior to 1863. These are scattered in the pages of many journals and transactions, and relate mostly to mineral analyses. He first demonstrated, by his analysis of the meteoric iron of Alabama, the presence of chlorine as a factor in this class of bodies. He was long an active member, and for many years the

President, of the Boston Society of Natural History, in whose Proceedings many of his contributions appeared. He has for some time been an inmate of an insane asylum, his case being regarded as hopeless.

James Blake, of San Francisco, is one of the few chemists in this country who has undertaken researches on the difficult department of physiological chemistry by experiments on the living subject. As early as 1839 he published "Observations on the Physiological Effects of Various Agents Introduced into the Circulation as Indicated by the Hæmadynamometer," and "Experimental Researches on the Mode of Operation of Poisons." Dr. Blake is the pioneer in this line of research.

Dr. Blake has also published "On Electrical Currents Produced during the Process of Fermentation and Vegetation." (*Phil. Mag.*, London, xii. pp. 539–541.)

His important memoir* "On the Effects of Various Saline Substances Injected into the Circulatory System" proves that there exists a close relation between the chemical properties of the substances experimented upon and their physiological effects; his experiments, going to prove that when introduced into the blood substances which are isomorphous exert similar actions on the living tissues; and that salts with the same base have analogous actions.

He tested the action of salts of magnesia, which were found, when introduced in any quantity into the blood, to arrest the action of the heart, with complete prostration of muscular power. The salts of zinc, isomorphous with those of magnesia, have a similar action, but produce the same effects in smaller quantities. The salts of copper, of lime, of strontia, of baryta, and of lead are considered in the order in which they are more closely related by their physiological actions. The peculiar action which the salts of the three last named substances exercise upon the muscular tissues, occasioning contractions in them during many minutes after death produced by their introduction into the blood. These muscular movements were in some cases observed forty-five minutes after the cessation of the heart's action. His experiments on the salts of silver and soda reveal a remarkable similarity in action upon the pulmonary tissue, on the heart, and on the systemic capillaries; for while in the case of all the other salts already mentioned, death seems to be produced by the destruction of the irritability of the heart, the fatal result with the salts of silver and soda is the consequence of their action on the tissues of the lungs. The physiological actions of the salts of ammonia and of potassa were found by Dr. Blake not to correspond with any of the preceding. Although agreeing perfectly with one another in their action upon the heart and the systemic capillaries, they differ extremely in their effects on the nervous tissues, ammonia being particularly distinguished from all inorganic compounds in this respect, and being very analogous to poisons derived from organic products, which it also resembles in its chemical properties. This last observation respecting ammonia, a nitrogenous compound, has received ample confirmation in the researches of later chemical physiologists, and especially in those of Dr. Richardson on the nitrites of the alcohol radicals and of Drs. Crum Brown and Fraser on the salts of the ammonium bases, derived from strychnia, brucia, and other alkaloids.

* Published in the French Archives Générales de Medicine for Nov. 1839. See also Brit. Assn. Rept., 1846, pp. 240–244, and Roy. Soc. Proceedings, iv., 1839, p. 155; Am. Journ. Med. Sci., 1849.

Dr. Blake has more recently extended his observations on this interesting subject to embrace the molecular weight as well as the isomorphism of the metallic salts and compounds of some of the metalloids. His paper will be found in the *Am. Jour. Sci.* for March, 1874, and his deductions are:—

1. In the changes induced in living matter by inorganic compounds, the character of the change depends more on the physical properties of the reagent than on its more purely chemical properties.

2. That the character of the changes is determined by the isomorphous relations of the electro-positive element of the reagent.

3. That among the compounds of the more purely metallic elements, the quantity of substances in the same isomorphous group required to produce analogous changes in living matter, is less as the atomic weight of the electro-positive element increases.

4. That the action of inorganic compounds on living matter appears not to be connected with the changes they produce in the proximate elements of the solids and fluids, when no longer forming part of a living body, at least in so far as our present means of research enable us to judge.

5. That in living matter we possess a reagent capable of aiding us in our investigations on the molecular properties of substances.

Wolcott Gibbs, Rumford Professor at Harvard College, has published:—

1840. "A Description of a New Form of Magneto-Electric Machine, and an Account of a Carbon Battery of considerable energy, communicated for this journal by Oliver Wolcott Gibbs, member of the junior class in Columbia College." *Am. Journ. Sci.* [1], xxxix. 132. This was the first mention of the use of carbon as the negative element in a voltaic couple.

1845. Dissertation on a Natural System of Chemical Classification. Brochure, New York, and *Am. Journ. Sci.* [1], xlix. 384.

1847. Chemischer-Mineralogischer Untersuchungen. *Pogg. Ann.*, lxxi. pp. 559–67.

1849. Analysis of Dust of a Sirocco which fell at Malta May 16th, 1846. *Sill. Journ.* [2], xi., 374, 1851. Also, *Abhandlungen der Akad.*, Berlin, 1847, and *Pogg. Ann., loc. cit.*

1851. January 1st Dr. Gibbs announced his intention to prepare for the columns of the *American Journal of Science* "Abstracts of the more important physical and chemical papers contained in foreign scientific journals, accompanied by references and by such critical observations as the occasion may demand." *Am. Jour.* [2], xi. 105. This purpose was steadily carried out by Dr. Gibbs for over twenty years; his well-known initials, W. G., appearing in almost every subsequent issue of the *American Journal of Science*, until 1873: an important service to science, the value of which was greatly enhanced by his notes and criticisms, which, of themselves, form a valuable contribution to chemistry. These abstracts and notes cover over 500 closely printed pages. It is far beyond our limits to cite all these "Notes" in detail. They are all referred to in the decade Indices of the *Journal*.

1852. Contributions to Analytical Chemistry. *Am. Journ. Sci.* [2], xiv. 204; also, *Pogg. Ann.*, lxxviii. 162.

1854. Note on a New Electro-Chronometric Method. *Proc. Am. Assn. Adv. Sci.*, viii. 103.

1854. On the Volumetric Determination of Nitric, Arsenic, Antimonic, and Stannic Acids, and on the

Separation of Manganese, Cobalt, and Nickel. *Ibid.*, viii. 247.

1854. On two New General Methods of Chemical Analysis. *Ibid.*, 248. These two papers were read but not printed in the volume of Proceedings, the titles only appearing there.

1855. Report on the Recent Progress of Organic Chemistry. *Ibid.*, ix. 37–61.

1858. On the Theory of the Polyacid Bases. *Ibid.*, xii. 190–197. In this paper the author relegates the discovery of the theory of water-types to Dr. Sterry Hunt; having, in his Report on the Progress of Organic Chemistry, read at Providence, ascribed it to Gerhardt and Williamson.

1858. Preliminary Notice of New Bases, containing Metals Associated with Ammonia. *Ibid.*, xii. 197–200.

1858. On the Rational Constitution of Certain Organic Compounds. *Am. Journ. Sci.* [2], xxv. 18–38.

1857. In joint authorship with F. A. Genth. "Researches on the Ammonia-cobalt Bases" (for full references see Genth).

1858. Also with Genth. Preliminary notice of a New Base, containing Osmium and the Elements of Ammonia. *Am. Journ. Sci.* [2], xxv. 248.

1860. Researches on the Platinum Metals (preliminary note.) *Am. Journ. Sci.* [2], xxix. 427.

1861. Remarks on the Atomic Weights of the Elements. *Am. Journ. Sci.* [2], xxxi. 248–256.

1861. Researches on the Platinum Metals. § 1 and § 2. *Am. Journ. Sci.* [2], xxxi. 63–70.

1862. The same continued, § 3. *Ibid.*, xxxiv. 341–356.

1864. The same continued, § 3. *Ibid.*, xxxvii. 57–61.

[This memoir was destined to appear in the Smithsonian Contributions, and was permitted by that Institution to appear in advance in the *Am. Journ. Sci.* Reference to it will be found in Smithsonian Reports for 1859, p. 35, and 1860, p. 39. The conclusion of the research has not yet been published.]

1864. "Contributions to Chemistry, from the Laboratory of the Lawrence Scientific School," viz.:—

1. "On the Relations of Hyposulphite of Soda to certain Metallic Oxides."

2. "On the Determination of Nitrogen by Weight."

3. "On the Separation of Cerium from Didymium and Lanthanum."

4. "On the Separation and Estimation of Cerium."

5. "On the Quantitative Separation of Cerium from Yttrium, Aluminium, Glucinum, Manganese, Iron, and Uranium."

6. "On the Employment of Fluoride of Potassium in Analysis." *Am. Journ. Sci.* [2], xxxvii. 344–358.

1865. "Contributions to Chemistry from the Laboratory of the Lawrence Scientific School, No. 2," viz.:—

1. "On the Separation of Chromium from Aluminium and Iron, etc. etc."

2. "On the Employment of Sodium for the Separation of Iron and Aluminium from other Bases."

3. "On the Separation of Manganese from Cobalt, Nickel, and Zinc."

4. "On the Separation of Cobalt from Nickel."

5. "On the Separation of Uranium from Cobalt and Nickel."

6. "On the Electrolytic Precipitation of Copper and Nickel as a Method of Analysis." *Am. Journ. Sci.* [2], xxxix. 58–65.

1867. On the Construction of a Normal Map of the Solar Spectrum. An abstract of a memoir read before the National Academy of Sciences, Aug. 7, 1866. *Am. Journ. Sci.* [2], xliii. 1–10.

1867. Contributions to Chemistry from the Lawrence Scientific School, No. 3, viz.:—

1. "On a New General Method of Volumetric Analysis."

2. "On the Precipitation of Copper by Hypophosphorous Acid."

3. "On the Precipitation of Copper and Nickel by Alkaline Carbonates."

4. "On the Employment of Sand and Glass Filters in Quantitative Analysis."

5. "On the Estimation of Manganese as Pyrophosphate." *Am. Journ. Sci.* [2], xliv. 207–217.

1867. "On certain points in the Theory of Atomicities." *Ibid.*, pp. 409–416.

1868. "On the Measurement of Wave-lengths by the Method of Comparison." Abstract of a paper read before the National Academy of Sciences, Aug. 16, 1867. *Ibid.*, xlv. 298–301.

1868. "On the Molecular Structure of Uric Acid and its Derivatives." *Ibid.*, xlvi. 289–298.

1869. "On the Wave-lengths of the Spectral Lines of the Elements." *Ibid.*, xlvii. 194–218.

1869. Contributions to Chemistry from the Laboratory of the Lawrence Scientific School, viz.:—

"On the Action of Alkaline Nitrites upon Uric Acid and its Derivatives." *Ibid.*, xlviii. 215–226.

1870. "Contributions to Chemistry, from the Laboratory of the Lawrence Scientific School," viz.:—

1. On a Simple Method of avoiding Observations of Temperature and Pressure in Gas Analysis.

2. On the Application of Sprengel's Mercurial Pump in Analysis. *Ibid.*, xlix. 370–371.

1870. "Miscellaneous Optical Notices." *Ibid.*, l. 45–54.

1873. Analytical Notices, viz.:—

1. On the Quantitative Estimation of Chromium and the Separation of Chromium from Uranium.

2. On the Estimation of Magnesium as Pyrophosphate. *Ibid.* [3], v. 110–117.

1873. "Researches of the Hexatomic Compounds of Cobalt" (being Part II. of the Researches on the Ammonia Cobalt Bases, by Gibbs and Genth). *Ibid.*, vi. 116–126.

1874. The same continued. *Ibid.* [3], viii. 189, 200, and 284–296.

James Lawrence Smith, Louisville, Ky.—Dr. Smith's name appears as a contributor to chemistry as early as 1841, when he wrote "On the Means of Detecting Arsenic in the Human Body," while he was yet a student in medicine in Paris. From that date to the present chemical readers are familiar with his contributions and researches, which have been both varied and important. For some years Dr. Smith was the chemical correspondent of the *American Journal of Science* in Europe. He has quite recently published a volume of his more important papers under the title of "Mineralogy and Chemistry, Original Researches," Louisville, Ky., 1873, 8vo., pp. 401. This volume contains the titles of forty-seven memoirs and papers. It opens with a memoir on Emery communicated to the Academy of Sciences of the French Institute in 1850. Before Dr. Smith's residence in Asia Minor very little was accurately known of the geology, mineralogy, and chemical history of emery. By this memoir, in two parts, we are put in possession of an exact and full history of its geology, mineralogy, and chemical constitution, as well as of that of its associated minerals, with descriptions of new

species, and many chemical analyses. In this research Dr. Smith devised a new method for determining the effective hardness of emery, and adopted, after many trials, the mode of attack by sodic-bisulphate as the only satisfactory means of breaking up the constitution of emery in an ultimate analysis. In the report of the commission of the Academy, Messrs. Cordier, Élie de Beaumont, and Dufrénoy, to whom Dr. Smith's memoir was referred, it is spoken of in terms of high encomium, and its insertion in the *Mémoire des Savants étrangers* was recommended.

In 1866 Dr. Smith extended his researches upon emery and its associate minerals to the interesting mine of that substance at Chester, Mass., first made known by Dr. C. T. Jackson, and this paper properly follows that on the emery of Asia Minor.

The minerals of Chili collected by the Astronomical Expedition to that country under Gillis were submitted to Dr. Smith for examination, and the results appeared in the first volume of Gillis's Report. They are now made accessible in Dr. Smith's volume of Memoirs.

The chemical examination of the "Thermal Waters of Asia Minor" has made known for the first time the constitution of some of the oldest thermals of a district renowned from the earliest historic period as the resort of invalids.

The most extended memoir in Dr. Smith's volume is that on the "Re-examination of American Minerals," which covers 76 pages of the work. The first part of this research was made jointly with Mr. Geo. J. Brush in 1853, at the University of Virginia, where Dr. Smith was then in charge of the chemical chair, and the paper appeared originally in the XVth and XVIth volumes of the *American Journal of Science*, in three parts. It included examinations, with analyses, of thirty-seven mineral species, or reputed species, the joint work of Smith and Brush, forming at the time the most important contribution to mineral chemistry yet made by any American chemists. The subsequent portion of this memoir is occupied with an examination, both physical and chemical, of the minerals of the Wheatley mine, and with the analyses of certain other species, the exclusive work of Dr. Smith. In these analyses the method used for the determination of the alkaline elements is that known as Smith's method, a detailed statement of which is given in a separate paper, pp. 200–221 of this volume, on the "Determination of Alkalies in Minerals," with a supplemental paper on the same subject "by ignition with carbonate of lime and sal-ammoniac" on pp. 293–401. These methods have passed into the literature of analytical chemistry. The American edition of Fresenius, by Johnson, says of the last named process, "Prof. Smith's method is by far the most convenient and accurate for separating alkalies from a silicate, and is universally applicable, except, perhaps, in presence of boracic acid." p. 303, vol. ii.

Dr. Smith's memoirs and researches upon meteorites have added much to our former knowledge of this interesting class of bodies, and are too well known to require more detailed mention here. Over one hundred pages of his volume of "Original Researches" are devoted to these memoirs.

Dr. Smith has added many ingenious appliances to our art in the way of apparatus, none of which is, perhaps, more noteworthy than his inverted microscope for chemical work.

Of his contributions to technical chemistry it is not our purpose to speak here, but his report on the "Progress and Condition of Several Departments of Industrial Chemistry," forming one of the series of documents published by the United States Government on the Paris Exposition of 1867, is familiar to all.

With Dr. Smith's volume of memoirs at hand, it is hardly needful to give here a detailed list of titles of his papers.

Traill Green, Lafayette College, Easton, Pa.—Prof. Green's papers are as follows:—

On the Atmosphere in Relation to Vegetation.

On Carbon and its Compounds. *The Educator.*

On Humine or Geine, the Food of Plants. *Agriculturist.*

On the Manufacture of Sugar from the Potato.

On Spontaneous Combustion.

Martin H. Boyé, Ph.D., Philadelphia.—Dr. Boyé's chemical papers have mostly been in joint authorship with others. I find the following titles:—

1846. Acetate of Lime formed in Coal Pits. *Proc. Chem. Phil. Soc.*, iv. 239.

1846. Oxide of Cobalt, with Brown Hematite, of Chester Ridge, Pa. *Ibid.*

1844. Analysis of the Bittern of a Saline on the Kiskiminetas River, near Freeport, Pa. *Sill. Journ.* [2], vii. 74, and *Proc. Am. Asso. Adv. Sci.*, 1848.

1850. Analysis of Schuylkill Water. *Sill. Journ.* [2], lx. 123.

In joint authorship with Clark Hare.

1842. On the Perchlorate of the Oxide of Ethyl, or Perchloric Ether. *Ibid.* [1], xlii. 63.

1842. On the Perchlorate of the Oxide of Ethyl, or Perchloric Ether. *Ibid.* With R. E. Rogers.

1842. On Magnesian Limestones. *Journ. Frank. Inst*

1842. On Magnesian Limestones. *Ibid.* With H. D. Rogers.

1841. New Compound of Deuto-chloride of Platinum, Nitric Oxide, and Chlorohydric Acid. *Am. Phil. Trans.*, viii. 59–65.

1846. New Compound of Deuto-chloride of Platinum, Nitric Oxide, and Chlorohydric Acid. *Ibid.* With C. M. Wetherill.

1846. Analysis of a Concretion from a Horse's Stomach. *Proc. Am. Phil. Soc.*, ix. 330. With J. C. Booth (see under Booth).

Benjamin Silliman.—Professor of Chemistry, Yale College, New Haven, Conn. His chemical and physical papers are—

1841. Electrography, or the Electrotype. *Am. Journ. Sci.* [1], xl. 157–164.

1841. Analysis of the Soil of the Nile. *Ibid.*, 190.

1842. A Daguerreotype Experiment by Galvanic Light (with Dr. W. H. Goode). *Ibid.*, xliii. 185.

This experiment was made in 1840, and is the earliest record of the fact, then an unexpected result, that the voltaic arc has photographic efficacy.

1842. On the Use of Carbon in Grove's Battery. *Ibid.*, xliii. 393.

1843. Description of a Carbon Voltaic Battery. *Ibid.*, xliv. 180–186.

1844. Review of Dana's Mineralogy. *Ibid.*, xlvi. 362–388.

1844. Analysis of Meteoric Iron from Burlington, Otsego Co., N. Y. *Ibid.*, xlvi. 401.

1845. Analysis of Blue Mud of New Haven Harbor. *Ibid.*, xlviii. 337.

1845. Notice of a Mass of Meteoric Iron found at Cambria, near Lockport, in the State of New York. *Ibid.*, xlviii. 388–392.

1845. Analysis of the Water of the Dead Sea. *Ibid.*, 10.

1846. On the Chemical Composition of Calcareous Corals. *Ibid.* [2], i. 189–199.

This investigation was undertaken upon the zoophites, collected by Prof. Dana on the Wilkes Exploring Expedition, and appeared in the work on Zoophites by that author. By it the occurrence of phosphoric acid and fluorine as constant factors of these organisms was first demonstrated.

1846. Chemical Examination of Several Natural Waters. (Report of the (Boston) Water Commissioners.) *Ibid.* [2], ii. 218–224.

1846. On the Meteoric Iron of Texas and Lockport (with T. S. Hunt). *Ibid.* [2], ii. 370–376.

1847. Hydrate of Nickel, a New Mineral. (Emerald Nickel.) *Ibid.* [2], iii. 407.

1847. "First Principles of Chemistry." A chemical manual revised in 1850 and 1853, and in which the fundamental ideas of the so-called "New Chemistry" were first distinctly brought out in a text-book in the organic portion prepared by Dr. Hunt. Over fifty thousand copies of this manual were distributed.

1847. Description (and analysis) of a Meteoric Stone which fell in Concord, New Hampshire, in October, 1846. *Ibid.* [2], iv. 353.

1848. On Chloroform. *Ibid.* [2], v. 240.

1849. On Gibbsite and Allophane, from Richmond, Mass. *Ibid.* [2], vii. 411–417.

1849. Description and Analysis of Several American Minerals. The subjects treated of in this article are as follows:—

I. Description and Analyses of Several Mineral Species belonging to the family of Micas.

II. Description and Analyses of Unionite, a new mineral species.

III. Description and Analyses of a Species resembling Worthite.

IV. Identity of Sillimanite, Bucholzite, and Fibrolite with Kyanite.

V. Analysis of a Granular Albite, associated with Corundum of Pennsylvania, and a new Analysis of the Indianite of Bournon.

VI. On Boltonite and Thomson's Bisilicate of Magnesia.

VII. On Nuttalite of Brooke.

Ibid. [2], viii. 377–394.

1850. On the New Mineral Lancasterite. *Ibid.*, ix. 216.

1850. Optical Examination of Several American Species. *Ibid.* [2], 372–383.

In this memorial the specific characters of Muscovite, Phlogopite, and Biotite, were first distinctly demonstrated as resting on optical phenomena.

1850. Analysis of Emerylite. *Ibid.*, p. 117.

1851. On Mammoth Cave. *Ibid.* [2], xi. 332–340.

1852. Daguerreotypes by Galvanic Light. *Ibid.*, 417.

1852. An Excursion on Etna. *Ibid.* [2], xii. 178.

1857. Notice of a Photometer, and of some Experiments therewith upon the Comparative Power of several artificial means of Illumination (with Chas. H. Porter). *Ibid.* [2], xxiii. 315.

1858. First Principles of Natural Philosophy, and—

1860. New edition of the same.

1859. Meteor of Aug. 11, 1859. *Ibid.* [2], xxviii. 300.

1860. On the Combustion of Wet Fuel in the Furnace of Moses Thompson. *Ibid.* [2], xxx. 243–253.

1860. Note on the Loss of Light by Glass Shades. *Ibid.*, 423.

1865. Examination of Petroleum from California. *Ibid.*, xxxix. 341.

1866. On Gaylussite from Nevada Territory. *Ibid.* [2], xlii. 220.

1867. On Naphtha and Illuminating Oil from heavy California Tar (Maltha). *Ibid.* [2], xliii. 242.

1869. On the Effect of Atmospheric Air when mixed with Gas in Reducing its Illuminating Power. (Joint paper with H. Wurtz.) *Ibid.* [2], xlviii. 41.

1869. Note on Wollongonite, a remarkable Hydrocarbon from N. South Wales. *Ibid.*, 85.

1870. On the Relation between the Intensity of Light produced from the Combustion of Illuminating Gas and the volume of Gas consumed. *Ibid.* [2], xlix. 17–24.

1870. On Flame Temperatures in their Relations to Composition and Luminosity (jointly with Henry Wurtz). *Ibid.*, 339–347.

1870. Note on Mr. Stimpson's Paper on Farmer's Theorem. *Ibid.* [2], 377.

1870. On the Determination of the Photometric Power of a Rich Gas by Dilution with a Poor Gas of known value. *Ibid.*, 379.

1873. On the Meteoric Iron found near Shingle Springs, Eldorado County, California. *Ibid.* [3], 18.

1873. Mineralogical Notes on Utah, California, and Nevada, with a description (and analyses) of Priceite, a new Borate of Lime. *Ibid.*, 126–133.

1874. Mineralogical Notes. Tellurium ores from Colorado. *Ibid.* [3], 25.

In the *Amer. Chemist*, July, 1871, vii. p. 18, 23:—

1871. "Report on the Rock Oil, or Petroleum, from Venango County, Pa."

This is a reproduction of a printed but unpublished report of 1855 (April), which is believed to be the earliest investigation into the chemical and physical properties of American petroleum, then collected only in surface pools, of a dark color and viscous quality, long before any Artesian borings had made known the vast extent and importance of this remarkable product.

F. A. P. Barnard, D.D., LL.D., President of Columbia College, New York. Nearly all Dr. Barnard's contributions to science, which are numerous and important, are physical. We note the following papers as falling within the scope of this essay.

1841. Improvement in the Daguerreotype process of Photography. *Am. Journ. Sci.* [1], lxi. 352.

1859. Means of preventing the Alteration of Metallic Surfaces as employed to close and break a voltaic circuit. *Proc. Am. Assn. Adv. Sci.*, vol. xiii. 1819, 208–216.

Fredk. A. Genth, Professor of Chemistry and Mineralogy in the University of Pennsylvania, has no superior in this country as an analytical chemist. His early chemical papers are to be found in the European journals, before his coming to America, in Berzelius's Jahresbericht; Liebig's Annalen; in Leonhard and Bronn's Jahrbuch; in Erdmann's Journal, and also in the German-American Keller-Tiedemann's Monatsbericht, etc. In Keller-Tiedemann's Monatsbericht appeared the first description of the ammonia cobalt bases, which he had discovered in Germany, in 1846. His first paper which I have seen is, "Chemische Unterschung des Masopins eines neuen Hartzartigen Körpers," in Wöhler and Liebig's Annalen, 1843, 116–124.

Dr. Genth has published most of his papers since coming to the United States in the *Am. Journ. of Sci.*

1853. "On the Allotropic Modification of Oxide of Cobalt" [2], xv. 120. "This corresponds to the allotropic modification of oxide of nickel," first noticed by Dr. Genth in 1845. *Ann. der Chem. und Pharm.*, liii. p. 139.

1853. "On a probable New Element with Iridosmine and Platinum, from California." [2], xv. 246.

1853. "On Rhodophyllite," xv. 438, and *Proc. Acad. Nat. Sci.* Phila. 1852, 121.

1853. "Contributions to Mineralogy: 1. Tetradymite; 2. Gray Copper; 3. Apophyllite; 4. Allanite" [2], xvi. 81–86, and continued; "5. Owenite; 6. Kämmerite, Emerald, Nickel." *Ibid.*, 167.

1854. "Contributions to Mineralogy: 1. Pyrophyllite; 2. Chrysotile; 3. Scolecite; 4. Owenite, identical with Thuringite" [2], xviii. 410, and continued; "5. Tetradymite; 6. Bismuthine; 7. Aciculite; 8. Barnhardite, a new mineral; 9. Gray Copper (Fahlerz); 10. Geokronite; (?) 11. Garnet; 12. Allanite; 13. Tungstates of N. Carolina; 14. Scorodite; 15. Wavellite." [2], xix. 15. In all these "contributions" are numerous and exhaustive analyses of minerals.

1854. "On a New Meteorite from New Mexico." xvii. 239.

1855. "Analysis of a Meteorite from Tuczon, Province of Sonora, Mexico." [2], xx. 110. Also in *Pro. Acad. Nat. Sci.*, vii. 317.

1855. "Herrerite identical with Smithsonite." *Ibid.*, 118.

1857. "Contributions to Mineralogy: 1. Bismuthine from Riddwehyttan in Sweden; 2. Harrisite (Shepard), a Pseudomorph of Copper Glance after Galena; 3. Cantonite, a Pseudomorph of Covelline after Galena; 4. Linnæite; 5. Enargite; (?) 6. Coracite (LeConte) is Pitch blende; 7. Epistilbite; 8. Shepard's Plumbo-Resinite is Cyanosite; 9. Cherokine (Shepard) is Pyromorphite; 10. Vivianite; 11. Wavellite; 12. Dufrenite; 13. Hitchcockite (Shepard); 14. Lanthanite; 15. Bismuthite." [2], xxiii. 415–427.

1857. In joint authorship with Wolcott Gibbs.

"Researches on the Ammonia-cobalt Bases. Part I." [2], xxiii. 234–265. *Ibid.*, 319–341; concluded in xxiv. 86–107. This memoir, more elaborate and fuller of new results than any chemical research before accomplished in this country, and which occupied the leisure of the authors for several years, formed part of the ninth volume of the "Smithsonian Contributions to Knowledge," from which it was reprinted as above.

1859. "Contributions to Mineralogy: Whitneyite, a New Species." [2], xxvii. 400.

1859. "Contributions to Mineralogy; 1. Native Iron; 2. Native Bismuth; 3. Whitneyite; 4. Barnhardite; 5. Gersdorffite; 6. Molybdate of Iron; 7. Albite; 8. Ripidolite; 9. Pholerite; 10. Scheelite; 11. Rhombic Tungstate of Lime; 12. Wolfram; 13. A few observations on the occurrence of gold." [2], xxviii. 246–255.

1862. "Contributions to Mineralogy: 1. Gold, pseudomorph after Aikinite; 2. Antimonial Arsenic and Arsenolite; 3. Arsenids of Copper; 4. Copper Glance, pseudomorphous after galena; 5. Millerite; 6. Proustite; (?) 7. Automolite; 8. Pyrope; 9. Lime Epidote; 10. Leopardite, a true porphyry; 11. Staurotide (?); 12. Chrysolite and Minerals resulting from its alteration; 13. Serpentine; 14. Kerolite; 15. Rammelsberg's Mineral Chemie." [2], xxxiii. 190–206.

1868. "Contributions to Mineralogy, No. VII.—1. Whitneyite; 2. American Tellurium Minerals. In this paper is described *Melonite*, a new mineral, Ni_2Te_3(?) *Calaverite*, a new mineral, $Au\,Te_4$; *Montanite*, a new mineral $BiO_3TeO_3 2HO$; and *Cosalite*, a new mineral $2PbS + BiS_3$. This paper, like all the former numbers of this series, has numerous analyses.

1870. "North Carolina's Mineral Resources, etc." *Franklin Inst. Journ.*, 1871 and 1872.

1874. "Contributions from the Laboratory of the University of Pennsylvania."

I. "Corundum, its alterations and associated minerals," *Proc. Am. Phil. Soc.*, September 19, 1874, p. 56, with many analyses.

There are a few other notices in the *Pro. of the Acad. Nat. Sci.*, and, on the occurrence of tin in America, in the U. S. Railroad and Mining Register, which we have not enumerated.

Henry How, D.C.L., Professor of Chemistry and Natural History University of King's College, Windsor, N. S., has published the following papers on chemistry and chemical mineralogy:—

1. Analysis of Ancient Peruvian Alloy. Read before Chemical Society of London, and published in their *Journal*, 1846.

2. Analysis of the Ashes of the Orange Tree, viz., of Root, Stem, Leaves, Fruit, and Seed, in conjunction with T. H. Rowney. Read before Chem. Soc. Lond., and published in their *Journal*, 1847.

3. Analyses of Coals of Great Britain, etc. Published in Blue Books for Houses of Parliament, containing reports by Sir H. De La Beche and Dr. Lyon Playfair on Coals suited to the Steam Navy, 1848–49.

4. On certain Salts and Products of Decomposition of Comenic Acid. Read before Roy. Soc. Edin., and published in *Transactions*, 1851.

5. On the Decomposition of Citrate of Lime in contact with Putrefying Curd. Read before Chem. Soc. Lond., and published in their *Journal*, 1851.

6. On Meconic Acid and some of its Derivatives. Read before Roy. Soc. Edin., and published in *Transactions*, 1852.

7. On some New Basic Compounds, obtained from Vegetable Alkaloids. Read before Chemical Soc. Lond., and published in their *Journal*, 1853.

8. On Platinum accompanying Silver in Solution in Nitric Acid. Read before Chemical Soc. Lond., and published in their *Journal*, 1853.

9. Report on Torbane Hill Mineral, so-called Coal, for the Instruction of Counsel in the case of Gillespie *v.* Russell. Edin., 1853.

10. On the Action of Halogen Compounds of Ethyl, and Amyl, on some Vegetable Alkaloids. Read before Roy. Soc. Edin., and published in *Transactions*, 1854.

11. On the Hyposulphites of the Organic Alkaloids. *Edin. New Phil. Journ.*, 1855.

12. Additional Experiments on the Ethers and Amides of Meconic and Comenic Acids. *Edin. New Phil. Journ.*, 1855.

13. On the Occurrence of the Mineral Natro-boro-Calcite in Gypsum of Nova Scotia. *Am. Journ. Sci.*, and *Edin. New. Phil. Journ.*, 1857.

14. Chemical Analyses of Farëelite and some other Zeolitic Minerals occurring in Nova Scotia. *Am. Journ. Sci.*, 1858.

15. Analysis and Description of Three New Minerals from Trap of Bay of Fundy. *Edin. New Phil. Journ.*, 1859.

16. On an Oil-Coal from Pictou Co., N. S., and the Comparative Composition of Minerals often included in the term "Coals." *Am. Journ. Sci.*, and *Edin. New Phil. Journ.*, 1860.

17. On the mineral Gysolite occurring in Trap of Bay of Fundy. Read before Roy. Soc. Edin.; published in *Am. Journ. Sci.*, and *Edin. New Phil. Journ.*, 1861.

18. On Natro-boro-Calcite and another Mineral, con-

taining Boracic Acid in Gypsum of Nova Scotia. Read before Roy. Soc. Edin.; published in *Am. Journ. Sci.*, and *Edin. New Phil. Journ.*, 1861.

19. On Pickeringite occurring in Slate in Nova Scotia, and on the Class of Salts to which it belongs. Read before Chem. Soc. Lond. and published in *Qu. Journ.*, 1863.

20. On some Mineral Waters of N. S. Read before Nat. Hist. Soc. Montreal; pub. in *Canadian Naturalist*, 1863.

21. On the Waters of the Mineral Springs of Wilmot, N. S. Read before N. S. Inst. Natural Science; pub. in *Transactions*, 1864.

22. On Mordenite; a New Mineral from Trap of N. S. Read before Chem. Soc. Lond.; pub. in *Qu. Journ.*, 1864.

23. Notes on the Economic Mineralogy of Nova Scotia, Part I., Iron Ores. Read before N. S. Inst. Nat. Sci.; published in *Transactions*, 1864.

24. Note on Purification of Oxalic Acid. *Chemical News*, 1864.

25. On a Dense Brine from Salt Springs, N. S. Read before Chemical Soc. London; published in *Journal*, 1865.

26. On some Brine Springs of Nova Scotia. Read before N. S. Institute Nat. Sci.; pub. in *Transactions*, 1865.

27. Notes on Economic Mineralogy N. S., Part II. Ores of Manganese. Read before N. S. Inst.; pub. in *Transactions*, 1865.

28. Notes on Econ. Min. N. S., Part III. Limestone and Marbles. Read before N. S. Inst.; published in *Transactions*, 1866.

29. On the Comparative Composition of some Recent Shells, a Silurian Fossil Shell, and Shell Limestone of Carboniferous Age. *Am. Journal of Science*, 1866.

30. Contributions to the Mineralogy of N. S., Part I., Pyrolusite, etc. *Lond., Edin., and Dub. Phil. Mag.*, 1866.

31. Contributions to the Mineralogy of N. S., Part II., Wichtyne, etc. *Lond., Edin., and Dub. Phil. Mag.*, 1867.

32. Contributions to the Mineralogy of N. S., Part III., Silico-boro-calcite, etc. *Lond., Edin., and Dub. Phil. Mag.*, 1868.

33. Notes on Econ. Min. N. S., Part IV., Gypsum and Anhydrite. Read before N. S. Inst. Nat. Sci.; pub. in *Transactions*, 1868.

34. On an Oxalate of Manganese. *Chemical News*, 1869.

35. On the New Precipitation of Manganese by Sulphide of Ammonium in Presence of some Organic Ammoniacal Salts. *Chem. News*, 1869.

36. Mineralogy N. S. Report to Provincial Government, pp. 217; Halifax, 1869.

37. Contributions to Mineralogy N. S., Part IV., Lignite, etc. *Lond., Edin., and Dub. Phil. Mag.*, 1869.

38. Notes on Econ. Min. N. S., Part V., Coals and Allied Minerals. Read before N. S. Inst. Nat. Sci.; pub. in *Transactions*, 1869.

39. Contributions to Mineralogy N. S., Part V., New Forms of Borates, etc. *Lond., Edin., and Dub. Phil. Mag.*, 1870.

40. Contributions to Mineralogy N. S., Part VI., Winkworthite, etc. *Lond., Edin., and Dub. Phil. Mag.*, 1871.

41. On an Acid Feed Water from Stellarton, N. S. Read before Chem. Soc. Lond.; published in their *Journal*, 1870.

42. On a Water from Coal Measures at Westville, N. S. Read before Chem. Soc. Lond.; pub. in their *Journal*, 1871.

43. On Two Coals from Cape Breton, their Cokes and Ashes, with some Comparative analyses. Read before Chemical Society London; published in *Qu. Journal*, 1874.

Thomas Sterry Hunt, Professor of Geology at the Massachusetts Institute of Technology, Boston.—The name of no American chemist occurs more frequently, or in a more important relation to the progress and development of our science, during the past quarter of a century than that of Dr. Hunt. His contributions to our science have been equally valuable in theoretical chemistry, in chemical philosophy, and in geological and mineralogical chemistry. No author has covered a wider range than he. Not less than one hundred and thirty entries are found under his name in the second and third series of the *American Journal of Science;* and adding those published in Canada, England, and France, and some memoirs in the proceedings of various American societies, the total roll of his papers amounts to about one hundred and sixty titles. A dry enumeration of these would be of little interest; we will rapidly allude to a few of them in the classified order named below.

I. *Theoretical Chemistry.*—The views of Laurent and Gerhardt found their first advocacy in this country at the hands of Dr. Hunt in his able review of the *Précis* of the latter in 1847 (*Amer. Journ. Sci.* [2], iv. 93–171), and his own papers in the years next following have contributed in no small degree to extend the bounds of theoretical chemistry and its philosophy. We mention in particular his paper "On the Anomalies in the Atomic Volume of Sulphur and Nitrogen," in 1848 (*Amer. Journ. Sci.* [2], vi. pp. 170–178). This paper contains also remarks on Chemical Classification and a notice of Laurent's Theory of Binary Molecules. In his paper, 2. "On some Principles to be considered in Chemical Classification," read at the Philadelphia meeting of the American Association, etc., in 1848, Dr. Hunt freely criticizes the systems of Liebig and of the French school, the rather to show their merits than their defects, and to exhibit their real harmony with each other and with nature. In this paper he advances his own views, showing what we all now recognize as the true constitution of gaseous nitrogen—NN—and that the various saline forms are reducible to two, the types of which are seen in water, H_2O, and the protoxyds, M_2O, and in the hydrogen, H_2, or the metals M_2, the first including all the oxygenized acids, and the second, the hydracids. 3. "On the Chemical Constitution of Gelatine and its Transformations."

4. "Remarks on the Constitution of Leucine and the Ureas" (*American Journal of Science* [2], ix. 63–67).

5. "On the Compound Ammonias and the Bodies of the Cacodyle Series," published in 1852 (*Amer. Journ. Sci.* [2], xiii. 206–211).

6. "On the Action of Sulphuretted Hydrogen upon Nitric Acetene," published in 1847, *Amer. Journ. Sci.* [2], iv. 350.

7. "On the Decomposition of Aniline by Nitrous Acid."

The last investigation points out a new mode of decomposition of organic bases, and in the case cited phenol was regenerated.

8. "On the Theoretical Relations of Water and Hydrogen." In this paper, published in March, 1854, Dr. Hunt reviews the opinions of the European chemists on the water-type, and reclaims (Dec. 30, 1853) for

himself the priority of authorship in this important conception which the English edition of Gmelin's Handbook (vol. vii. pp. 17 and 201) ascribes to Williamson.

9. "On the Theory of Types in Chemistry," is the title of a memoir of Dr. Hunt's, dated January 5, 1861 (*Amer. Journ. Sci.* [2], xxxi. pp. 256–263), in which he ably reviews the history of the subject, and shows that in the series of papers whose titles are above quoted, 1 to 9, were first developed the views of the *water-type* and of *multiple or condensed types* which were subsequently adopted by Williamson, Gerhardt, and Ad. Wurtz. Dr. W. Gibbs, in an essay presented by him at the Baltimore meeting of the American Association for Ad. Science, May, 1858, remarks that in a previous paper of his (his "Report on the Progress of Organic Chemistry") he had attributed the theory of water-types to Williamson and Gerhardt, and adds, "in this I find I have not done justice to Mr. T. Sterry Hunt, to whom is exclusively due the credit of having first applied the theory to the so-called oxygen-acids and to the anhydrids, and in whose earlier papers may be found the germs of most of the ideas on classification usually attributed to Gerhardt and his school."

10. "Theory of Nitrification and Nature of Gaseous Nitrogen" (*Amer. Journ. Sci.*, 1848), further developed with experiments on the oxidation of nitrogen by permanganic acid, and the origin of nitrous acid, forming a key to the true origin of nitrites and nitrates in nature. This view was adopted without change or addition by Schönbein in 1862, and without acknowledgment. See Hunt's Reclamation in the *Amer. Journ. Sci.* [2], xxxv. pp. 271–273, 1863.

Other views of fundamental importance have been put forth by Dr. Hunt on Theoretic Chemistry, but we must pass them and make brief mention of some of his more important contributions to—

II. *Chemical Philosophy.*—1. "Considerations on the Theory of Chemical Changes, and on Equivalent Volumes." This paper appeared in 1852 (*Amer. Journ. Sci.* [2], xv. 226), and is a more condensed statement of the same views developed by the author in an "Introduction to Organic Chemistry," which appeared in Silliman's Chemistry in the same year.

2. "Thoughts on Solution and the Chemical Process" (*Amer. Journ. Sci.* [2], xix. 100). In this paper the ground is taken that all solution is chemical union.

3. "On the Objects and Method of Mineralogy" (*Amer. Journ. Sci.*, [2], xliii. 203.)

4. "On the Constitution and Equivalent Volume of some Mineral Species." This is an elaborate memoir (*Amer. Journ. Sci.*, Sept. 1853), in which the author develops his views respecting the homology of chemical formulas, and the similarity of volume in isomorphous species, looking to an enlargement and simplification of the plan of chemical science, and leading to a correct mineralogical system.

5. "Illustrations of Chemical Homology." In this paper, read at Washington, in 1854, before the American Association for Advancement of Science (viii. 237), the author gives a greater extension to his former paper just named (4) and discussed many points with regard to the homologies of organic and mineral species. Here will be found developed his views on the constitution of the feldspars, which were some years later adopted without acknowledgment by Tschermak.

Besides these contributions already cited, Dr. Hunt has been a constant worker in the analyses of minerals, and has made many important—

III. *Studies in Geological and Mineralogical Chemistry.*—We can only mention in passing:—

1. Analyses of Warwickite, Columbite, Samarskite, Rutherfordite, in early volumes of the *Amer. Journ. Science.*

2. On Euphotide, Saussurite, and related Diorites, an elaborate study with many analyses, published in 1859 in the *Amer. Journ. Science.*

3. On the Labrador Feldspars, printed in the *London Phil. Magazine* for 1855.

4. Contributions to the Chemistry of the Ophiolites, vols. xxv. and xxvi., *Amer. Journ. Sci.*, 1858. An elaborate research with numerous analyses forming part of the Geological Reports of Canada.

5. "Contributions to Lithology. I. Theoretical Notions. II. Classification and Nomenclature. III. On some Eruptive Rocks" (*Amer. Journ. Sci.* [2], xxxvii. 248, and xxxviii. 91 and 248, 1864). This elaborate memoir gives the composition of the various eruptive rocks of the district of Montreal, with the author's theoretical deductions therefrom.

6. "Contributions to the History of Natural Waters" (*Amer. Journ. Sci.*, 1865). In this memoir is given the theory of the origin of mineral-waters, with studies of their composition, illustrated by the waters of the St. Lawrence basin, and the chemical relations of each element. This research is in part in the Geological Survey of Canada for 1867.

7. "On Some Reactions of the Salts of Lime and Magnesia and on the Formation of Gypsum and Magnesian Rocks" (*Amer. Journ. Sci.*, 1859). This very elaborate memoir exhibits a great amount of chemical work, and treats—I. of the action of solutions of bicarbonate of soda on salts of lime and magnesia. II. On the reaction between solutions of bicarbonate of lime and the sulphates of soda and magnesia. III. On the formation of double carbonate of lime and magnesia. IV. Facts in the history of gypsums, dolomites, magnesites, and limestones. V. On the mode of formation of the preceding rocks. This was followed by a supplementary paper, entitled "Farther Contributions to the Chemistry of Lime and Magnesia Salts" (*Amer. Journ. Sci.*, 1866).

In this connection it is but just to mention that in addition to the work here recorded, Dr. Hunt has in the volumes of the Geological Survey of Canada given analyses of a vast number of rocks, soils, ores, etc., contributions toward the chemistry of ore-deposits in Canada, etc.

But time fails us even to name the work of Dr. Hunt in many other important researches of a like nature. "Researches on the Artificial Production of Earthy Silicates, and some points in Chemical Geology and the Chemistry of the Metamorphic Rocks," published in the *Quarterly Geological Journal*, London, from 1859 to 1863. His "Chemical Theory of the Globe;" "The Chemistry of Chaos;" "Chemical Origin of Rocks, Sea, Atmosphere, Ore Deposits, Mineral Species, Volcanoes," developed in various papers in the *Amer. Journ. Sci.*, the *Smithsonian Report* for 1869, and the author's address at Indianapolis before the American Association for the Advancement of Science, on the "Origin of Crystalline Rocks," and his "Contributions to the Chemistry of Copper" (*Amer. Journ. Sci.*, 1870).

A volume containing some of the more important of Dr. Hunt's original papers here enumerated, and others, is now in press, and will soon appear, simultaneously, in Boston and in London.

John L. LeConte, M.D., Philadelphia.—This eminent naturalist made his inaugural dissertation on a

chemical investigation, which has been published as follows:—

On a New Species of Urinary Concretions, by John L. LeConte, M.D. *New Journal of Medicine and the Collateral Sciences*, 1846, vol. vii. p. 172.

E. N. Horsford, Cambridge, Mass.—Prof. Horsford's chemical papers are as follows:—

1846. Uber den Werth Verschiedener Vegetabilischer Nahrungsmittel, hergeleit aus ihrem Stickstoffgehalt *Liebig's Annal.*, lxiii. 166, translated in *Sill. Journ.*, ii. 264.

1846. Analyse der Ashe des Kleies Trifolium praetense. lviii. 391, *Liebig Annal.*

1846. Uber den Ammoniakgehalt der Gletscher. *Liebig Annal.*, lix. 113.

1846. Uber Glycocoll (Leimzucker) und einige seiner Zersetzungs producte. *Liebig Annal.* lxi. Translated in *Sill. Journ.*, iii. 369, iv. 58, 326.

1846. List of Sweet Bodies. *Proc. Am. Acad.*, i. 303. Chemical Essays Relative to Agriculture. *Sill. Journ.*, ii. 144.

1847. Warrentrapp and Will's Method for the Determination of Nitrogen improved. *Sill. Journ.* [2], iv. 267.

1848. Strecker's Researches on Ox-gall. *Ibid.* [2], v. 17.

1848. Resistance presented to Fluids by Electric conduction. *Ibid.* [2], v. 36.

1848. New Blast Lamp. v. 36, *Ibid.* [2].

1848. Liebig's New Mode of separating Nickel and Cobalt. *Ibid.* [2], v. 411.

1848. On Motions of Fluids in Animal Bodies. *Ibid.* [2], v. 415.

1848. Contamination of Water, etc. *Am. Acad. Proc.*, ii. 62–99.

1848. Explosion of Burning Fluids. *Proc. Am. Ass.*, ii. 178, 179.

1849. On the Moisture, Ammonia, and Organic Matters of the Atmosphere. *Ibid.*, ii. 124, *Liebig Annal.*, lxxiv. 243, 1850.

1849. Note on Soda in the Ashes of Anthracite Coal. *Proc. Am. Ass.*, 233.

1849. On Color of Fused Sulphur. *Proc. Am. Ass.*, 234.

1851. Occurrence of Placid Waters in the Midst of large Areas where Waves are constantly breaking. vi. 41, *Proc. Am. Ass.*

1850. On the Relation of Barium, Strontium, etc. *Sill. Journ.* [2], ix. 176.

1851. Plasticity of Sulphur. *Proc. Am. Ass.*, vi. 63.

1851. Relation of Chemical Constitution to Light. *Proc. Am. Ass.*, 74.

1856. Ammonia in the Atmosphere. *Ibid.*, x. 145.

1863. Salts of Zinc, Aluminium, Sodium, Potassium. *Mem. Am. Acad.*, viii. 354–360.

1851. Analyses of Teas. *Sill. Journ.* [2], xi. 249.

1851. Relation of Chemical Constitution to taste. *Ibid.* [2], xii. 195.

1852. Permeability of Metals to Mercury. *Ibid.* [2], xiii. 305.

1853. Solidification of the Coral Reefs of Florida, and the Source of Carbonate of Lime in the Growths of Corals. *Proc. Am. Ass.*, vii. 122.

1868. Source of Free Hydrochloric Acid in Gastric Juice. *Ibid.*, xvii. 178.

1868. Phosphoric Acid a Constituent of Butter. *Ibid.*, xvii. 114.

1869. Phosphoric Acid, Iron, and Potassium, Constituents of Chlorophyl. *Ibid.*, 147.

John W. Mallett, Professor of Chemistry in the University of Virginia, at Charlottesville, Va., has for many years been an industrious worker, publishing original researches on chemical subjects, which form important contributions to our science. The destruction of the buildings of the University of Alabama, by the Federal Cavalry during the late civil war, has deprived Prof. Mallett (who was formely Prof. of Chemistry at Tuscaloosa) of all means of responding to the call for his papers, but the following list is as complete as it could be conveniently made by us from the materials at hand.

1850. On the Minerals of the Auriferous Districts of Wicklow. *Phil. Mag.* [3], xxxvii. 392.

1845. Chemical Examination of Killinite. *Dub. Geol. Soc.* iv.—*Chemist*, I. 47–49, 1849–50.

1851. Occurrence of Gadolinite in Ireland. *Phil. Mag.* [4], i. 350.

1851. Beobachtungen über das Telluräthyl. *Liebig Ann.* [4], xxix. 223.

1852. On a New Fossil Resin. *Phil. Mag.* [4], iv. 261.

1853. Analysis of Euclase. *Phil. Mag.* [4], v. 127.

1853. On a Siliceous Deposit from the Hot Volcanic Springs of Taupo. *Phil. Mag.* [4], v. 285.

1854. Analysis of Tin Pyrites. *Sill. Journ.* [2], xvii. 23.

1854. Analysis of Idocrase from Ducktown, Polk Co., Tenn. *Ibid.* [2], xx. 85.

1854. On Phosphates of Iron and Manganese from Norwich, Mass. *Ibid.* [2], xviii. 33.

1855. On Crystallization of Platinum from Fusion. *Ibid.* [2], xv. 340.

1856. Redetermination of Lithium. *Am. Assn.*, x. 144.

1856. On a Zeolitic Mineral from the Isle of Skye. *Phil. Mag.* [4], xii. 406–552.

1857. Atomic Weight of Aluminium. *Brit. Assn. Report*, p. 53.

1857. On the Atomic Weight of Lithium. *Phil. Mag.* [4], xiii.

1857. Results of some Analyses made for the Geol. Survey of Alabama. *Sill. Journ.* [2], xxiii. 181.

1857. Notice of a supposed new case of Fluorescence. *Ibid.* [2], xxiii. 434.

1857. On the Separation of Lithia and Magnesia. *Ibid.* [2], xxiii. 427.

1857. On the Rose-colored Mica of Goshen, Mass. *Ibid.* [2], xxiii. 180.

1857. Separation of Magnesia and Lithia. *Ibid.* [2], xxiv. 137.

1858. Schrotterite from Cherokee Co., Alabama. *Ibid.* [2], xxvi. 79.

1859. On Brewsterite. *Ibid.* [2], xxviii. 48.

1860. Metallic Copper and Dinoxyd of Copper. *Ibid.* [2], xxx. 253.

1859. Nitrate of Zirconium. *Am. Assn.*, xiii. 217.

1859. Atomic weight of Lithium. *Am. Assn.*, xiii. 221.

1860. Osmious Acid and the position of Osmium in the list of elements. *Phil. Mag.* [4], xix. 293.

1861. Chemical and Physical Conditions of the Culture of Cotton. *Proc. Royal Soc.*, xi. 340.

J. D. Whitney, Cambridge, Mass.—Mr. Whitney's chemical work has been in mineral chemistry. He has published as follows:—

1849. Examination of American Minerals. *Sill. Journ.* [2], vii. 433, 434. *Proc. Boston Nat. Hist. Soc.* 1849, p. 48.

1849. On some Silicates containing Carbonic Acid, Chlorine, and Sulphuric Acid. *Sill. Journal*, vii. 435. *Pogg. Ann. der Ph. und Ch.*, lxx. 431.

1849. On Chloritoid and Masonite; and Black Oxide of Copper, Lake Superior. *Sill. Journ.* [2], viii. 273. *Proc. Boston Nat. Hist. Soc.* 1849, p. 100.

1854. Analysis of Algerite and Apatite. *Sill. Journ.*, xvii. 206.

1860. On Pectolite. *Ibid.* [2], xxix. 205.

1860. Analysis of Pyroschists. *Ibid.*, lxvi. 160.

William Phipps Blake has written chiefly on geological and kindred topics; but we find in 1850 an article by him on the "Occurrence of Crystallized Oxyd of Chromium (Cr) in Furnaces for the Manufacture of Chromate of Potash," giving the crystallographic and other physical characters of the substance. *Am. Jour. Sci.*, 2, x. No. 30, Nov. 1850.

Mr. Blake was the first to recognize the *tellurids* among the mineral products of California. His Report on the Precious Metals, forming one of the governmental volumes on the Paris Universal Exposition of 1867, is replete with valuable information. Mr. Blake first drew attention to the platinum metals associated with the gold washings of California, and published an analysis of the mass made for him in Dr. Genth's laboratory in 1854. "Report of a Geological Reconnaissance of California," 4to. pp. 300.

1850. "On Dimorphism of Copper," *Am. Ass. Proceedings*, iv. p. 151.

1850. "New Instrument for Measuring the Angles contained between the Optic Axes of Crystals and for Goniometrical Purposes," *Ibid.*, pp. 378–221.

John M. Ordway, Chemical Laboratory of the Massachusetts Institute of Technology, Boston.—All of Prof. Ordway's papers, with a single exception, have been published in the *Am. Journ. of Sci.*, 2d series. They are as follows:—

Memoirs.

1850. Nitrates of Iron, Alumina, and Chromium. *Am. Journ. Sci.*, ix. 30.

1865. Nitrates of Iron. *Id.*, xl. 316.

1859. Some Facts respecting the Nitrates. *Id.*, xxvii. 14.

1857. Some Soluble Basic Salts of Tin. *Id.*, xxiii. 220.

1858. Examination of the Soluble Basic Sesquisalts. *Id.*, xxvi. 197.

1858. A new Mode of making Commercial Caustic Soda. *Id.* xxvi. 364.

1861–1865. On Waterglass, a series of five articles. *Id.*, xxxii. 153, 337; xxxiii. 27; xxxv. 185; xl. 173.

Reviews.

1856. Wetherill's Manufacture of Vinegar. *Am. Journ. Sci.*, xxxi. 450.

1867. Schützenberger's Traité des Matières Colorantes. *Id.*, xliii. 421.

1867. Mulder's Die Chemie der auströckende Oele. *Id.*, xliv. 438.

1868. Assmass' Die Trockne Destillation des Holzes. *Id.*, xlv. 274.

Obituary Sketches.

1868. Dr. S. L. Dana. *Id.*, xlv. 424. Author of the same in *Proc. Am. Acad. Arts and Sci.*, viii. 26.

Wm. H. Brewer, New Haven, Connecticut.—Prof. Brewer's contributions to chemistry are:—

1850. Determinations of Nitrogen in two Varieties of Indian Corn. *Proc. Am. Assoc. Adv. Sci.*, iv. 386.

Prof. Brewer has also contributed Analysis of Minerals to Dana's Mineralogy, etc.

George J. Brush, Sheffield Scientific School, New Haven.—All the chemical researches of Prof. Brush fall under the head of chemical mineralogy, to which he has made important contributions. Besides the subjoined list, he has contributed analyses of minerals to the third, fourth, and fifth editions of Dana's *Mineralogy*, and to the various supplements. Of the latter he edited the eighth, ninth, and tenth, published in the *American Journal of Science*, and also the appendix to the fifth edition, recently published by Wiley. So large a part of the work of American chemists has been devoted to mineralogy, which, in the larger sense, is only a department of chemistry, that we have no right to consider such researches as not falling within the scope of our essay.

Papers on chemical mineralogy published by Prof. Brush are found in the *American Journal of Science*, viz.:—

Second series:—

Vol. x. pp. 370. Analyses of American Spodumine.
" xv. pp. 207. } Re-examination of American Mine-
" xvi. pp. 41. } rals. By J. Lawrence Smith and
" xvi. pp. 365. } George J. Brush. Parts I.–III.

This joint work of Profs. Smith and Brush includes the examination of the following minerals:—

Part I. Emerylite, euphyllite, Litchfield mica, unionite, kerolite, bowenite, williamsite, lancasterite, hydromagnesite, magnesite.

Part II. Chesterlite, loxoclase, Danbury feldspars, Haddam albite, Greenwood mica, biotite, margarodite, Chesterlite talc, rhodophyllite, cummingtonite, hydrous anthophyllite, monrolite, ozarkite, dysyntribite, gibbsite, emerald nickel.

Part III. Danburite, carrollite, thalite, hudsonite, jenkinsite, lazulite, kyanite, elæolite, spodumene, petalite.

Vol. xviii. pp. 407. On the Chemical Composition of Clintonite (Seybertite).
" " pp. 415. On a New Test for Zirconia.
" xx. pp. 273. On Prosopite.
" xxiv. pp. 128. On the Chemical Composition of Antigorite.
" xxiv. pp. 116. On Dechenite and Eusynchite.
" xxiv. pp. 124. Note on Parathorite.
" xxv. pp. 198. Chemical Composition of Chalcodite.
" xxvi. pp. 64. Mineralogical Notices: Analyses of Gieseckite (?) from Diana, Compact Pyrophyllite, Unionite, Danbury Feldspar.
" xxvii. pp. 395. Chemical Examination of Boltonite.
" xxxii. pp. 94. On Crystalline Hydrate of Magnesia.
" xxxiv. pp. 243. On Amblygonite from Maine.
" " pp. 402. On Triphyline from Norwich, Mass.
" xxxvi. pp. 122, 257. On Childrenite from Hebron, Maine.
" " pp. 152. On the Tucson Meteoric Iron.
" xxxvii. pp. 66. On Tephroite.
" xxxix. pp. 132. On Artificial Diopside.
" xli. pp. 246. On Cookeite and Jefferisite.
" xliv. pp. 219. On Native Hydrates of Iron.
" xlvi. pp. 140, 240. On Sussexite.

Vol. xlviii. pp. 17. On Hortonolite.
" " pp. 17. On Durangite.
" " pp. 179. On a Meteoric Stone from Frankfort, Alabama.
" " pp. 360. On Magnetite in the Pennsville Mica.

Third series:—
Vol. I. pp. 28. On Galenite from New Jersey.
" II. pp. 30. On Ralstonite.
" V. pp. 421. On Compact Anglesite.

Henry Wurtz, Hoboken, New Jersey.—Prof. Wurtz, who was at one time professor of chemistry in the Columbian Medical College at Washington, D. C., is now chemical editor of the Gas Light Journal in New York. His chemical contributions date from 1850, as follows. [Prof. Wurtz has furnished us the following notes on his papers.]—

1850. On a Supposed New Mineral Species. *Am. Journ. Sci.* [2], x. p. 80, July.

1850. On the Green Sand of New Jersey as a Source of Potash. Read to the American Association at New Haven, August, 1850. *Ibid.*, p. 326, November. [Analyses given of two raw green sand marls containing 6·38 per cent., and 4·94 per cent. of KO. The fact first announced that dilute sulphuric acid yields *alum* directly, readily crystallizing out from solution of the green sand granules. Previous ignition peroxidized the iron chiefly, and the alum then obtained was mostly free from iron. The fact was first announced that when the grains, even without pulverization, were fused at a low temperature with chloride of calcium, in sufficient proportion to form a pasty mass, complete double decomposition was effected, and the mass yielded to water, "all the potash which was contained in the green sand employed in the form of chloride of potassium." Upon this was founded "a method of decomposing minerals in the process of analysis," presented to the Association at the same meeting. Sulphate of potash was obtained by fusing together alum and chloride of potassium.]

1850. On a New Method of Decomposing Silicates in the Process of Analysis. Read to the American Association at New Haven, August, 1850. *Ibid.* [2], x. p. 323, November. [Feldspar and hornblende were found, when fused with chloride of calcium, to be completely fluxed, and decomposable by muriatic acid. It was suggested to use, at times, chloride of barium, instead of chloride of calcium, because of its freedom from deliquescence. A mixture, in equivalent proportions, of the chlorides of barium and strontium was found very advantageous, from its far greater fusibility. An analysis was given, made by this method, of the pink scapolite of Bolton, Massachusetts.]

1851. On Bromine as a Toxicological Agent. By Henry Wurtz, Assistant in the Yale Analytical Laboratory. *Ibid.* [2], xi. 405, May. [Bromine with water and heat was used to replace chlorine to destroy the organic matter of stomachs, etc., to isolate mineral poisons.]

1852. On the Preparation of Pure Hydrate and Carbonate of Potash. *New York Journ. Pharm.* February, 1852, i. 33. [Elimination of silica from solutions of potassic carbonate by evaporating with the addition of carbonate of ammonia in lumps. Superiority of flint-glass bottles for solutions of potassic hydrate, on account of their greater resistance to corrosion. Preparation of pure hydrate from pure potassic sulphate, by reduction to sulphide, and boiling with oxide of copper, manganese, or iron. Residual undecomposed sulphate removed by solution of baric hydrate.]

1852. Preparation of Chemically Pure Hydrate and Carbonate of Soda. *Ibid.*, i. 36, February, 1852. [Commercial bicarbonate of soda is freed from sulphate, phosphate, and chloride by washing with water by decantation, then dried on the sand-bath, and exposed to a heat below redness, to expel CO_2. On solution in water, the silica is chiefly left in flakes. Remaining traces of silica then removed by evaporation with addition of lumps of ammonic carbonate, and resolution. To obtain dry pure carbonate, the last solution is then re-evaporated in vessels of Pt, Ag, or clean Fe, avoiding glass and porcelain. To obtain pure sodic hydrates, the carbonate must be decomposed by lime, which is free from silica.]

1852. Preparation of Pure Barium Compounds (with other subjects). *Ibid.*, June, 1852, i. 161. [The important point is here the first announcement of the power of baric carbonate, either precipitated, or pulverized witherite, to precipitate gypsum totally from its solutions; with the first suggestion to utilize this property for purifying waters for steam purposes, sea-water included. Brine of salt works also mentioned as a proper subject.]

1852. Preparation of Pure Magnesia. *Ibid.* i. 199. [Commercial *magnesia alba* dissolved in nitric acid, and by digestion with an excess of the carbonate, all silica, ferric oxide, alumina, and PO_5 separated. To eliminate lime, some magnesic sulphate and alcohol added, the latter in quantity insufficient to cause immediate precipitation. In the course of time the lime crystallizes out as gypsum. The liquid is then evaporated and heated, with stirring and addition of powdered carbonate of ammonia, to expel the nitric acid. On ignition, and washing with distilled water after cooling —to remove sulphates and alkaline salts—chemically pure magnesia remains. Oxalate of lime was found to be appreciably soluble in magnesic solutions, and hence lime could not be eliminated as oxalate from such solutions.]

1852. On the Preparations of Iron used in Medicine. *Ibid.*, i. 229. [Preventing oxidation of ferrous compounds by introducing into the bottle fragments of quicklime wrapped in paper. Alcohol will not preserve ferrous salts, as generally supposed, as it absorbs oxygen from the air, and conveys it thereto. To obtain ferrous sulphate free from ferric salt, baric carbonate employed. Another new mode, by agitation with pulverized protosulphide of iron. To obtain pure ferric oxide, dissolve separately in hot water five of recrystallized copperas, six of crystallized sodic carbonate, and one of nitrate of soda, filter, mix, evaporate to dryness, and heat the mass to faint redness. Water then leaves undissolved a heavy impalpable, but perfectly soluble, ferric oxide. Coal gas is proposed to be used, instead of hydrogen, in making *pulvis ferri*.]

1853. Purification of Sal Ammoniac. *Ibid.*, ii. 1, January, 1853. [The yellowish portions of loaves of sal ammoniac were known to be ferriferous. The transparent colorless parts were found to be equally so, and the iron found to be present as FeCl. The yellow color is not due to iron. Neither sublimation nor crystallization eliminated the iron, though so asserted in the books. Brewer's process of purification here first published—with Cl and NH_3.]

1856. On the Composition of the Water of the Delaware River. By Henry Wurtz, New Jersey State Chemist. *Am. Journ. Sci.* [2], xxii. 124, November, 1856. [Includes also an analysis of the water of springs proceeding from the crystalline gneiss rocks at Trenton, New Jersey.]

1858. Action of Nitric Acid on the Metallic Chlorides. *Am. Journ. Sci.* [2], xxv. 39, May, 1858. [This extended research, which is continued in the same journal, vol. xxvi. page 81, covered the behavior of hot nitric acid upon the chlorides of K, Na, Li, NH_4, Mg, Ca, Sr, Ba, Al, Gl, Fe, Mn, Co, Ni, Zn, Cd, Cu, Cr, U, Hg, Pb, Ag, Au, Pt, Sn, As, Sb, Bi, Ce, La, Di, Th, Zr, Mo, and V. Many new and important facts were developed, too numerous to detail here.]

1858. Detection of Nitric Acid in Solution, with Observations on the Action of Ferric Salts upon Indigo and Metallic Gold, and on the Neutralization of the Colors of Metallic Solutions. *Ibid.*, xxvi. 49, April. Read to the American Association in Baltimore, in April, 1858. [Containing the first observations of the power of ferric solutions to dissolve metallic gold and platinum.]

1858. A Method of Separation of Magnesia from the Alkalies. Read to the American Association in Baltimore, April, 1858. *Ibid.*, xxvi. 83. [The bases, as chlorides, are converted into nitrates by evaporation with nitric acid, ignition, and washing with water.]

1858. Action of Nitric Acid in the Cold upon some Metallic Solutions, with new modes of obtaining pure Compounds of Barium, Strontium, and Cadmium. *Ibid.*, 188. Read to the American Association, at Baltimore, April, 1858. [BaCl and CdCl, in strong solution, gave instantly, and SrCl more slowly, crystalline precipitates of pure nitrates. HgCl was also instantly precipitated, but went down as such, and not as nitrate. KCl and NaCl gradually form nitrates in the cold.]

1858. Suggestions regarding Economical Applications of Glycerine. Read to the American Association at Baltimore, April, 1858. *Ibid.*, xxxi. 195. [Mixing with mustard and other condiments, confectionery, chocolate, chewing tobacco, filling gas meters, making copying ink, etc.]

1858. Preparation of Pure Sulphates, etc. By Henry Wurtz, Professor of Chemistry in the National Medical College, Washington, D. C. *Ibid.*, xxvi. 367. [Elimination of iron from cupric sulphate by conversion to ferric oxide by ebullition with a little plumbic deutoxide, or even with minium, and then adding baric carbonate. The same method is applied to a great number of other sulphates, including Epsom salt. Referring to former paper, in which the precipitation of gypsum by baric carbonate is brought out, it is further suggested that plumbic carbonate be used for this, the lead being recovered again.]

1858. Improvements in the Preparation of Hard Minerals for Analysis. Read to the American Association at Baltimore in 1858. *Ibid.* 190. [Proposed to crush always in a hard iron mortar, and then to remove the abraded iron with iodine-water, also with a neutral solution of ferric chloride. When earthy carbonates are present, remove them first by boiling with ammonic chloride or nitrate, then iodine. Pyrrhotine was found to be separable from pyrites, by dissolving in iodine-water, the pyrites being insoluble therein. Elutriation of minerals in the iron mortar *with alcohol* recommended.]

1858. Chemical Examinations connected with a Bullet which had been imbedded for more than forty years in a Human Lung. *Ibid.*, 192. [The bullet was found corroded and partly encrusted with plumbic chloride, and the liquid in the enveloping cyst also contained lead. The body of the lung and the muscle of the diaphragm were found to contain lead.]

1858. Action of Hot Muriatic Acid upon some Metallic Nitrates. *Proc. Am. Ass. Advt. Sci.* (Baltimore, 1858), 181.

1859. On the Occurrence of Cobalt and Nickel in Gaston County, North Carolina. *Am. Journ. Sci.*, xxvii. 24, April, 1858.

1859. Modes of Increasing the Heat of the Mouth Blowpipe, with some blowpipe manipulations. *Ibid.*, xxvii. 24. [Paraffine candles proposed. Blowpipe with tube filled with potassic hydrate. Powdered silica may be fused or semi-fused into transparent globules. Borax beads, so highly supersaturated with oxides as to become opaque on cooling, found to remain transparent, if plunged while hot into cold water, and colored reactions thus brought out. New facts and experiments on interference of colors in blowpipe beads. Decolorization of ferriferous glass by manganese, shown to be due, in part at least, to such neutralization of colors.]

1866. Sodium Amalgam. *Ibid.* [2], li. 216.

1866. On Grahamite. *Ibid.*, lii. 420.

1869. Atmospheric Air mixed with Gas. *Ibid.*, lviii. 40.

1870. Gas Well in New York. *Ibid.*, lix. 336.

1870. On Flame Temperatures. *Ibid.*, lix. 339.

Samuel W. Johnson, Professor of Theoretical and Agricultural Chemistry in Yale College, has made the following contributions to chemistry :—

Memoirs and Lectures.

On the Houghite of Prof. Shepard. *Am. Journ. Sci.*, xii. (1851), pp. 361–365.

Chemische Notizen: 1. Chromsaures Kali-ammoniak; 2. Chromsaures Natron, Leichte Berçitungsweise desselben; 3. Ueber Kartoffel-fuselöl, Vorkommen von Propylalkahol und Caprinsäure in demselben; 4. Verbindung von Amylalkohol mit Chlorcalcium. *Journ. für Prakt. Chemie*, lxii. (1854), pp. 261–264.

Ueber das zweifach schleimsaure amyloxyd. *Journ. für Prakt. Chemie*, lxiv. (1855), pp. 107–9.

Ueber die schleimsauren Salze der Alkalien. *Liebig's Annalen*, xciv. (1855), pp. 224–230.

Chemische Untersuchung verschiedener Pflanzenaschen, Bodenarten, und Gewässer. *Liebig's Annalen*, xcv. (1855), pp. 226–242, von Prof. O. Sendtner und S. W. Johnson.

Essay on the Physical Properties of Soils as affecting Fertility. *Trans. N. Y. State Ag. Soc.*, 1856, pp. 101–124.

Examination of two Sugars (Panoche and Pinite) from California. *Am. Journ. Sci.*, xxii. (1856), pp. 6–8.

Lecture on the Relations that exist between Science and Agriculture. *Trans. N. Y. State Ag. Soc.*, 1857, pp. 73–95.

Lectures on Agricultural Chemistry. *Report of Smithsonian Institution*, 1859, pp. 78.

On Some Points of Agricultural Science. *Am. Journ. Sci.*, xxvii. (1859), pp. 71–85.

Soil Analysis. Notice of the Agricultural Chemistry of the Geological Surveys of Kentucky and Arkansas. *Am. Journ. Sci.*, xxxii., 1861, pp. 20.

With joint authorship of O. D. Allen.

On the Equivalent and Spectrum of Cæsium. *Am. Journ. Sci.*, xxxv. (1863), pp. 7.

The Assimilation of Complex Nitrogenous Bodies by Vegetation. *Am. Journ. Sci.*, xli. (1866), pp. 4.

With joint authorship of John M. Blake.

On Kaolinite and Pholerite. *Am. Journ. Sci.*, xliii. (1867), pp. 13.

Sources and Supply of Nitrogen to Crops. *Lecture to Conn. Board of Agriculture*, 1867, pp. 25.

On Native Crystallized Terpin. *Am. Journ. Sci.*, xliii. (1867), pp. 2.

On the Estimation of Carbonic Acid, and on Construction of Bunsen's Air-pump. *Am. Journ. Sci.*, xlviii. (1869), pp. 111–114.

On Nitrification. *Am. Journ. Sci.*, xlvii. (1869), pp. 234–242.

Soil Exhaustion and Rotation of Crops. Two Lectures. *Report of the Conn. State Board of Agriculture*, 1871, pp. 47.

On the Estimation of Nitrogen. *Am. Chemist*, iii. (1872), pp. 161–2.

On the Use of Potassium Dichromate in Ultimate Organic Analysis. *Am. Journ. Sci.* [3], vii. (1874), pp. 465–8.

Reports.

Reports to the Connecticut State Agricultural Society, Hartford, Ct.

For 1857. General Considerations on Manures; Examination of forty-three fertilizers, pp. 58.

For 1858. Essay on the Nature and Agricultural Uses of Peat and Swamp Muck, and Analyses of thirty-two samples; Examination of twelve fertilizers, pp. 174.

For 1859. Examinations of twenty fertilizers, pp. 67.

Reports to the Connecticut State Board of Agriculture.

For 1868. Examinations of sixteen fertilizers, pp. 18.

For 1869. Valuation of Commercial Fertilizers, pp. 18.

For 1872. Composition of the Ash of Connecticut Tobacco leaf, etc., pp. 40.

For 1873. Analyses of thirty-one Commercial Fertilizers, pp. 21.

Systematic Treatises.

Peat and its uses as a Fertilizer and Fuel. N. Y., O. Judd & Co., 1866, pp. 168, 12mo.

How Crops Grow. N. Y., 1868, pp. 394.

The same, edited by Church and Dyer, London, 1869.

The same in German, translation by Baron H. v. Liebig. Braunschweig, 1871.

The same in Russian, translation by N. R. Temashev. St. Petersburg, 1873.

How Crops Feed. N. Y., 1870, pp. 375.

The same in German, translation by Baron H. v. Liebig. Braunschweig, 1872.

Any notice of Prof. Johnson's contributions to chemistry would be extremely deficient, should it fail to mention his well-known edition of Fresenius' Manual of Qualitative and Quantitative Analysis, in two volumes, 1869–1870. A new edition of this work by Prof. Johnson is now in preparation.

John Leconte, Oakland, California. — Dr. Leconte's contributions to science are all from the physical side, and how important they are is too well known to require comment. He is now the Professor of Physics and Mechanics in the University of California. The following physico-chemical papers by Dr. Leconte fall properly within our scope.

1. "Observations on a Remarkable Exudation of Ice from the Stems of Vegetables, and on a Singular Protrusion of Icy Columns from Certain Kinds of Earth during Frosty Weather." *Proceedings of American Association for Adv. of Sci.*, 3d Meeting, at Charleston, S. C., March, 1850, pp. 20–34.—*Lond., Edin., Dub., Phil. Mag.*, 3d S., vol. xxxvi. pp. 329–342, May, 1850.

2. "Observations on the Freezing of Vegetables, and on the Causes which enable some Plants to endure the action of Extreme Cold." *Proceedings of Am. Assoc. for Adv. of Sci.*, 6th Meeting, at Albany, N. Y., August, 1851, pp. 338–359.—*Am. Journ. of Sci. and Arts*, 2d S. vol. xiii. pp. 84–92 and 196–206, Jan. and March, 1852.

3. "Preliminary Researches on the alleged Influence of Solar Light on the Process of Combustion." *Proceedings of Am. Assoc. for Adv. of Sci.*, 11th Meeting, at Montreal, C. E., Aug. 1857, Part I., pp. 93–109.—*Am. Journ. Sci. and Arts*, 2d S. vol. xxiv. pp. 317–330, Nov. 1857. Also, *Lond., Edin., Dub., Phil. Mag.*, 4th S. vol. xvi. pp. 182–197, Sept. 1858.

4. "On the Influence of Musical Sounds on the Flame of a Jet of Coal-Gas." *Am. Journ. Sci. and Arts*, 2d S. vol. xxv. pp. 62–65, Jan. 1858. Also, *Lond., Edin., Dub., Phil. Mag.* 4th S. vol. xv. pp. 235–239, March, 1858.

5. "On the Adequacy of Laplace's Explanation to Account for the Discrepancy between the Computed and the Observed Velocity of Sound in Air and Gases."—*Lond., Edin., Dub., Phil. Mag.*, 4th S. vol. xxvii. pp. 1–33, Jan. 1864. The latter part of No. 5 touches upon the question whether the atmosphere is a *Mechanical Mixture* or a Chemical Compound.

James Schiel, Ph.D., St. Louis, Mo.—Dr. Schiel's chemical contributions in the *American Journal of Science* are—

1853. On the Separation of Manganese from Iron and Nickel [2], xv. 275.

1855. On the identity of Sanguinarine and Chelerithene, and on the direct determination of Nitrogen [2], xx. 220–222. Compare *Ann. de Chem. und Pharm.*, Liebig and Wöhler, B. xliii. 233.

[See entry under Dr. James F. Dana.]

1860. On the Products of the Distillation of Common Rosin [2], xxx. 100–102.

Dr. Schiel is also the author of a systematic treatise on Analysis, entitled "*Anleitung zur Organischen und Gasanalyse*," Erlangen, 1860. 8vo. pp. 200.

Charles A. Joy, Ph.D., Professor of Chemistry, Columbia College, New York. Professor Joy has published—

1852. Analyse des Narwall-zahns und des Gehaüses von Helix Pomatia. *Ann. der Ch. und Pharm.*, lxxxii., Bd. 3, Heft 365.

1853. Uber das Selenäthyl. *Ibid.*, lxxxii. 35.

1853. Analyse des Meteoreisens von Cosbys Creek. *Ibid.*, 39.

The chemical papers by Dr. Joy, published in the *Am. Journ. of Sci.*, are as follows:—

1863. On Glucinum and its Compounds. [2], xxxvi. 83–91.

1864. Analysis of a Meteorite from Chili. *Ibid.*, xxxvii. 243–248.

Prof. Joy has been a constant contributor to the current literature of science in various publications not available for our present purpose.

Besides the papers enumerated, Prof. Joy has contributed to Dana's Mineralogy the chemical analyses of several minerals. The research on selenäthyl cited above, is among the earliest contributions to a class of alcohol radicals combined with a metallic base which appeared in chemical literature.

Charles A. Goessmann, Ph.D., of Amherst, is now the chemist of the Massachusetts Agricultural College located at Amherst. During his residence at the salines of Syracuse Dr. Goessmann made himself well known by his able discussion of the chemistry of brines. But Dr. G.'s contributions to chemistry cover a wide range, and prior to his coming to this country he was a frequent contributor (1854–58) to the *Annalen von Wöhler, Liebig, and Kopp*, as will be seen by the following list of chemical papers:—

In 1854. *Annalen der Chemie u. Pharmacie, von Wöhler, Liebig, u. Kopp*
- On Palmitic Acid — Bd. 89—H. 123
- On Arachidic Acid—a new fatty acid — 89—i.-11
- On the Composition of the Cocoa-Oil — 90—126
- On Benzoglycolic Acid from Hippuric Acid — 90—181
- On a New Mode of Procuring Ethylamin — 90—122
- On the Constitution, etc., of Leucine — 91—129

In 1856. A New Mode of Procuring Amarine u. Lophine — 93—329
- On Hypogaeic Acid—a new acid in Peanut Oil — 94—230

In 1856. On the Combinations of Arachidic Acid — 97—257
- On the Constitution of the Lophine — 97—283
- On the Separation of Coumarin — 98— 86
- On the Separation of Styracin
- On Certain Products from Hypogaeic Acid, Gaidic Acid, etc. (This paper was published by C. A. G. and G. C. Caldwell, of Cornell University) — 99—305
- On Manganate of Potassium as a Suitable Substance to Decolorize Uric Acid, Hippuric Acid, etc. — 99—373
- On a New Mode of Procuring Triphenylamine — 100— 57
- On the Action of Zinc Chloride on Hippuric Acid — 100— 69
- On the Crystallization of Sulphocyanide of Silver — 100— 76

In 1857. On the Action of Iodide of Ethyl on Tungstate of Silver — 101—218
- On a New Mode of Producing Tricapronylamine — 101— 31
- On the Transformation of Nitrobenzol into Aniline by Means of Arsenious Acid and Caustic Potassa — 102—127
- On a New Sugar Plant, Sorghum Saccharatum — 104—335

In 1858. Contribution to the Knowledge of the Nature of the Chinese Sugar-cane, Sorghum Saccharatum; see Transactions of the New York State Agricultural Society, of 1861, 785.

In 1862. Report on the Chemical Composition of the Brines of Onondaga, New York: Syracuse, December, 1862.

In 1862–63. Report on the Brines of Michigan; see. Senate Report. New York: 1862—63. (House Documents); also,
House Committee of the Legislature of Michigan. No. 37. 1865.

In 1863. Report on the Best Mode of Manufacturing Coarse or Solar Salt from the Brines of Onondaga. Syracuse: December, 1863.

In 1864. Contribution to the Manufacture and Refining of Sugar; or the Application of Caustic Magnesia for Sugar Refining. Syracuse. Reprinted, *Chemical News*, London, etc., 1864–65.

In 1865. Notes and Criticism on the Manufacture of Sugar upon the Island of Cuba. Syracuse. Reprinted, *Chemical News*, London, etc., 1865.

In 1866. Contribution to the Chemistry of the Mineral Springs of Onondaga. Syracuse: February, 1866. Also *Amer. Journ. of Sci.*, September and October, 1866.

In 1867. Report on the Salt Deposit of Petite Anse, Louisiana. Published by the American Bureau of Mines. New York: January, 1867.
Contribution to the Chemistry of Brines. *Amer. Journ. of Sci.*, July and November, 1867.

In 1868. Report on the Salt Resources of Goderich, Canada. Syracuse.

In 1869. On the Chemistry of Common Salt with Reference to our Home Resources. Read before the National Academy at the Northampton Meeting; see *Amer. Journ. of Sci.*, January, 1870.
On Salt and its Uses in Agriculture; see Report of Massachusetts State Board of Agriculture. Boston: 1870.

In 1870. On the Cultivation of the Sugar Beet-Root as an Agricultural Enterprise. College Report of the Trustees of the Massachusetts Agricultural College. December, 1870; see also *Amer. Chem.*, 1871.
On Cheese as Food; see Report of American Dairymen's Association, Utica, New York, January, 1870.

In 1871. Report on the Chemical Composition of some Dairy Products; see Annual Report of the Massachusetts State Board of Agriculture, 1871–72, pp. 305.

In 1872. On the Stassfurt Potash Compounds, and their Present Reputation in the Agricultural Industry of Europe; See *Amer. Chem.*, 1872. July.
Report on the Quality of Sugar Beet-Roots raised upon the Farm of the Massachusetts Agricultural College, with regard to their Fitness for Sugar Manufacture; see *Amer. Chem.*, 1872.
Contribution to the History of the Beet Sugar Manufacture within the United States; See *Amer. Chem.*, 1872, July.
Contributions to the Requirements for a Successful Home Beet Sugar Industry; see *Amer. Chem.*, 1872, August and November.

In 1873. On the Fertilization of our Farm Lands with Reference to the Judicious Application of Mineral Fertilizers; see Journal of New York State Agricultural Society of January and February, 1873.

In 1873. Report on Commercial Fertilizers, and their Importance in our Present Condition of Agricultural Industry; see Tenth Annual College Report of the Massachusetts Agricultural College, 1873.

On Nitrogen and the Extent of its Natural Resources for Agricultural Purposes; see Report of Massachusetts State Board of Agriculture of 1873–74.

In 1874. Results of Experiments with the Cultivation of the Sugar Beet-Roots throughout the State of New York, Eastern Canada, and upon the College Farm during the year 1873; see College Report for 1873–74.

Report on the Present Condition of our Resources of Commercial Concentrated Fertilizers; see First Official Report of the State Inspector, C. A. G., Amherst, Mass., July 8, 1874.

Eugene W. Hilgard, Ann Arbor, Mich.—Prof. Hilgard, long of the University of Mississippi, and attached to the Geological Survey of that State, is now the Professor of Chemistry at the University of Michigan.

His chemical papers are as follows:—

1. Beitrag zur Kenntniss der Lichtflamme (Inaug. Diss.). *Ann. Chemie und Pharm.*, vol. xcii. p. 129, 1854. (Fifteen analyses of the gases from the "dark cone" of the tallow and wax flames; demonstrating the presence of N and H in the lowest parts of the flame, the absence of free O, and *the combustion of C prior to H*, contrary to the statement in most text-books.)

2. On the Quantitative Assay of Chromium by blowpipe processes. In *Proc. A. A. Sc.*, 1857; abstract *Am. Journ. Sci.*, 1857.

3. On the Condition of our Knowledge of the Chemical Processes in Luminous Hydrocarbon Flames. *Proc. Am. A. Sc.*, 1868.

4. On the Geology of the Delta, and the Mudlumps of the Passes of the Mississippi. *Am. Journ. Sci.*, vol. I., 1871, with analyses of the waters and gases, and a discussion.)

5. On Soil Analyses and their Utility. *Am. Journ. Sci.*, Dec, 1872.

6. On the Silt Analysis of Soils and Clays. *Am. Journ. Sci.*, Oct. and Nov. 1873.

7. Silt Analyses of Mississippi Soils and Sub-soils. *Am. Journ. Sci.*, Jan. 1874.

Analyses of soils and rocks published in various Geological Reports.

John M. Maisch, Philadelphia. Pennsylvania.—Mr. Maisch has been editor of the *American Journal of Pharmacy* since the death of Mr. Procter, whose labors have been before mentioned. His chemical researches have been chiefly in pharmaceutical chemistry, and have been published in the *American Journal of Pharmacy* and in *Proceedings of the American Pharmaceutical Association*, as follows:—

Proximate Analysis.

Notes on the Alkaloids of Menispermum Canadense. *Am. Journ. Pharm.*, 1863, p. 301.

Berberina in Podophyllum Peltatum. *Ibid.*, 1863, p. 303.

On Resin of Podophyllum, Solubility in Boiling Water. *Ibid.*, 1874, p. 231.

Absence of Alkaloids in the Dead Stalks of Veratrum Viride. *Ibid.*, 1864, p. 98.

Alkaloid in Solanum Pseudo-Capsicum. *Ibid.*, 1864, p. 99.

Active Principle of Rhus Toxicodendron (Toxicodendric Acid). *Proc. Am. Pharm. Assn.*, 1865, p. 166.

Balsams of Liquidambar styraciflua and Orientale. *Am. Journ. Pharm.*, 1874, p. 163.

Chinese Blistering Bugs (Amount of Cantharidin in). *Proc. Am. Pharm. Assn.*, 1872, p. 246.

Chemical Examination of Coca Leaves. *Am. Journ. Pharm.*, 1861, p. 496.

Adulteration Notes, Assays, etc.

Carbonate of Lime substituted by Sulphate of Lime. *Am. Journ. Pharm.*, 1854, p. 210.

Examination of Bitartrate of Potassa. *Ibid.*, 1855, p. 204.

A New Falsification (Nitrobenzole) of Oil of Bitter Almonds. *Ibid.*, 1857, p. 544.

Examination of Adulterated Oil of Peppermint. *Ibid.*, 1860, p. 105.

Analysis of Commercial Glacial Phosphoric Acid. *Ibid.*, 1860, p. 193.

On the Detection of Croton Oil in Mixtures. *Ibid.*, 1860, p. 306.

Assay of Milk. *Ibid.*, 1860. p. 431.

Adulteration of Carmine. *Ibid.*, 1861, p. 17.

Assay of Commercial Iron by Hydrogen. *Ibid.*, 1861, p. 20.

Tests for the Purity of Glycerin. *Ibid.*, 1867, p. 117.

Note on Cheap Glycerin. *Ibid.*, 1867, p. 309.

Detection of Turmeric in Powdered Rhubarb and Mustard. *Ibid.*, 1871, p. 259.

On Volatile Oils (Detection of Adulterations). *Proc. Am. Pharm. Assn.*, 1858, p. 344.

Behavior of Essential Oils to Iodine and Bromine. *Ibid.*, 1859, p. 338.

Occasional Occurrence of Arsenic in American Sulphuric Acid. *Ibid.*, 1863, p. 255.

Assay of French Brandy and Whiskey. *Ibid.*, 1864, p. 291, and 1866, p. 267.

Quality and Assay of Sherry Wine. *Ibid.*, 1863, p. 296, and 1866, p. 269.

Analysis of a Chalybeate Water from Sharon Spring, New York. *Am. Journ. Pharm.*, 1861, p. 105.

Inorganic Chemistry.

Effects of Sunlight upon Solution of Ferrous Iodide. *Am. Journ. Pharm.*, 1854, p. 408, and 1855, p. 218.

Solubility of Iodides in Syrup of Ferrous Iodide. *Ibid.*, 1857, p. 210.

Protiodide of Mercury (Processes for obtaining it). *Ibid.*, 1857, p. 11.

Alumen Exsiccatum (Heat required for preparing it). *Ibid.*, 1860, p. 16.

Crystalline Forms of the Chlorides of Potassium and Ammonium. *Ibid.*, 1860, p. 521.

Conversion of Monohydrated into Common Phosphoric Acid. *Ibid.*, 1861, p. 385.

Pyrophosphate of Soda and Iron. *Ibid.*, 1867, p. 388.

Hydrobromic Acid (Preparation of). *Proc. Am. Pharm. Assn.*, 1860, p. 220.

Organic Chemistry.

On the Strength of Diluted Acetic Acid. *Am. Journ. Pharm.*, 1858, p. 306.

Notes on Benzoic Acid and some Benzoates. *Ibid.*, 1860, p. 204.

Specific Gravity of Aqueous Solutions of Tartaric Acid. *Proc. Am. Pharm. Assn.*, 1863, p. 204.

Acid Reaction of Chloral Hydrate. *Ibid.*, 1873, p. 621.

Chloride of Mercurethyl (Review of Literature). *Am. Journ. Pharm.*, 1873, p. 9.

Citrate of Ammonia a Solvent for Phosphate of Iron. *Ibid.*, 1859, p. 410.

Solution of Citrate of Magnesia. *Ibid.*, 1867. p. 1.

Solution of Acetate of Iron. *Ibid.*, 1867, p. 7.

Preparation of Heavy Oil of Wine. *Ibid.*, 1865, p. 100.

Decomposition of Pure Chloroform. *Proc. Am. Pharm. Assn.*, 1866, p. 264, and *Am. Journ. Pharm.*, 1868, p. 289.

On Amylo-Nitrous Ether (Preparation of Nitrate of Amyl). *Am. Journ. Pharm.*, 1871, p. 146.

Monobromated Camphor (New Process, Properties, Analysis). *Ibid.*, 1872, p. 337.

On Colchicia. *Ibid.*, 1867, p. 97.

Decomposition of Acetate of Morphia in Aqueous Solutions. *Ibid.*, 1871, p. 49.

Precipitation of Morphia Salts by Alkaline Cyanides. *Ibid.*, 1871, p. 258.

Decomposition of Sulphate of Quinia by Acetates. *Ibid.*, 1855, p. 97, and 1858, p. 385.

Precipitation of Quinia by Iodide of Potassium from Acid Solutions. *Ibid.*, 1871, p. 51.

Solubility of Glue in Glycerin. *Ibid.*, 1870, p. 515.

Theo. G. Wormley, M. D., Professor of Chemistry and Toxicology at Starling Medical College, Columbus, Ohio, is widely known to chemists by his beautiful work, "The Micro-Chemistry of Poisons," which, as an original contribution to the special department of chemistry which it covers, has no equal in any language. This work is unrivalled in its exquisite plates, drawn and engraved by the graceful hand of Mrs. Wormley. Besides this standard work, Dr. Wormley has contributed the following original papers:—

"Systematic Quantitative Analysis of Urine," *Ohio Med. and Surg. Journ.*, vol. vii. July, 1855.

"Chemical Reactions of Strychnine," *Amer. Journ. Sci. and Arts*, 2d series, xxviii. Sept. 1859.

"Chemical Reactions of Atropine," *Chemical News* (London), vol. ii. June, 1860.

"Chemical Reactions of Brucine," *Ibid.*, ii. July, 1860.

"Chemical Reactions of Morphia," *Ibid.*, ii. Sept. 1860.

"Chemical Reactions of Narcotine and Meconic Acid," *Ibid.*, ii. Sept. 1860.

"Chemical Reactions of Corrosive Sublimate," *Ibid.*, ii. No. 43.

"Chemical Reactions of Veratrine," *Ohio Med. and Surg. Journ.*, xii. No. 6, 1860.

"Chemical Reactions of Nicotine and Daturine," *Ibid.*, vol. xiii. No. 1.

"Chemical Reactions of Solanine," *Ibid.*, vol. xiii. No. 2.

"Chemical Reactions of Codeine, Meconine, Narceine, and of Aconitine." *Ibid.*, xiii. No. 4, 1861.

"Chemical Reactions of Conine," *Ibid.*, xiv. No. 1, 1862.

"Chemical Reactions of Oxalic Acid," *Ibid.*, xiv. No. 5.

"Contribution to our Knowledge of the Chemical Composition of Gelseminum Sempervirens," *Amer. Journ. Pharmacy*, 3d series, xviii. No. 1, 1870.

The last-named paper contains an account of the mode of preparation and the chemical and physiological properties of a new alkaloid (gelseminine), and of a new organic acid (gelseminic acid).

"Methods of Analysis of Coals, Iron Ores, Furnace Slags, Fire Clays, Limestones, and of Soils," *Report of Progress of Geological Survey of Ohio for* 1870.

Dr. John C. Draper, of the College of the City of New York, has made the following contributions:—

1. "Origin of Urea in the Body," *N. Y. Journ. of Med.*, Feb. 1856.

2. "Products of Respiration," *N. Y. Med. Times*, July, 1856.

3. "Determination of the Diurnal Amount of Sunshine by the Precipitation of Gold," *Lond. Phil. Mag.*, Aug. 1859.

4. "Insensible Perspiration," *Proceedings of N. Y. Academy of Medicine*, 1864.

5. "Adulterations in Coffee," *Lond. Phil. Mag.*, Aug. 1867.

6. "Improvement in Filtration," *Ibid.*, May, 1870.

7. "New Light Unit," *Scientific American*, Oct. 21, 1871.

8. "Causes of Decay in Brick and Stone," *Ibid.*, Nov. 25 and Dec. 2, 1871.

9. "New Process for the Quantitative Determination of Arsenic," *American Chemist*, June, 1872.

10. "Growth of Seedling Plants," *Amer. Journ. of Science and Arts*, Nov. 1872.

11. "Influence of Cold on the Temperature of the Body," *Ibid.*, Dec. 1872.

(To be continued in the November Chemist.)

BREVITIES.

Determination of Sulphate of Lead. — For the determination of sulphate of lead in commercial chromate of lead, according to the process of M. Duvillier, 1 part of the chromate, 2 to 3 of nitric acid, density 1·420, 1 to 2 of distilled water, ¼ part of alcohol, are heated slowly in a large flask. We have thus in solution a mixture of nitrate of lead and nitrate of chromium and a white precipitate of nitrate of lead, which also retains the sulphate of lead. By boiling further in water, nothing remains undissolved except the sulphate of lead.—*The Engineer.*

Action of Ammonia on Sugar. — On employing absolutely dry sugar, and submitting it to the action of a current of ammoniacal gas, dried over a long column of quick-lime, the sugar becomes at first opalescent, and takes the waxy consistence described by Raspail, but in the course of twelve hours, says Laborde. it liquefies, and flows on the surface of the tube in which it is contained; 100 parts of sugar absorb 7·83 of ammonia. On exposure to the air, the sugar loses the ammonia which it had absorbed. At the end of three months the sugar retains only about 0·37 per cent., and has still a very pungent flavor. Glucose similarly treated liquefies very rapidly, becoming colored, and forming a crystalline product.—*The Engineer.*

William Fairbairn, LL.D, the distinguished British Engineer and iron manufacturer, died August 18th, at the age of eighty-five. He built the first iron ships in England, and this became one of the principal branches of his business. He was associated with Stephenson in building the Menai strait tubular bridge. Mr. Fairbairn, who was one of the founders of the British Association, wrote many able papers on subjects connected with his profession, and published several important works, among which may be noticed "Mills and Mill Work," "Iron—Its History and Manufacture," "Application of Iron to Building Purposes," "Iron Shipbuilding," and First, Second, and Third Series of "Useful Information for Engineers." Mr. Fairbairn was a corresponding member of the National Institute of France, and a Chevalier of the Legion of Honor. He had been President of the British Association, and had declined the honor of knighthood.

On the Use of Potassium Dichromate in Ultimate Organic Analysis.—Prof. S. W. Johnson recommends a mixture of three parts of prepared kaolin with two parts of fused and pulverized pure dichromate for ordinary combustions. For graphite fifty-five per cent. dichromate is used. Ordinary kaolin or fire clay, clean sifted, is strongly ignited for half an hour in a crucible, then intimately mixed with eight per cent. commercial potassium dichromate, by evaporating upon it a solution of the salt; then ignite it for an hour in a covered crucible, and place it while hot in stopped bottles. This constitutes the prepared clay, and is mixed, as first mentioned, with the dichromate.

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FLUORESCENT RELATIONS OF CHRYSENE AND PYRENE.

BY HENRY MORTON, PH.D.

Being desirous of comparing the fluorescent properties of the later products of coal tar distillation with those of the "chrysogen" already examined,* I applied to Mr. J. H. C. Cheever, superintendent of the works of Messrs. Page, Kidder & Fletcher, at Bull's Ferry, and, thanks to his kindness, and to the liberality of the last-named gentlemen, who authorized the necessary experiments, I was abundantly supplied with the requisite material.

I should fail to do justice to the scientific zeal manifested by Mr. Cheever, did I omit to relate that several explosions and one melting out of a still, were encountered in the course of procuring this supply.

The substances of which I was in search were the chrysene and pyrene, which had been isolated and studied by Messrs. Græbe and Liebermann, and which are described by them in the *Annalen der Chemie und Pharmacie*, 1871, vol. lxxxi. pp. 285, 315.

They describe the material on which they worked as being that obtained by distilling coal tar to coke, and as being moreover a solid of a yellow color, showing, on fracture, large crystalline plates of a greenish fluorescence.

By treating this with cold carbonbisulphide, a sulphur-yellow powder was left which consisted chiefly of chrysene, the pyrene being obtained from the solution.

The material obtained by Mr. Cheever, as already related, differed so much in general character from this description that it was only the confidence, that from the mode of preparation the pyrene and chrysene must be in it, that inspired me with courage to attempt their extraction. Thus, in the first place, the product, as deposited from the still, had the appearance of a brick-red powder, which, however, on being touched, showed itself to be pre-eminently adhesive, and by pressure, heat, or the action of solvents, settled into a thick tar, which in the property of "stickiness" would without doubt be "*facile princeps*" among all such bodies.

Once introduced into a vessel it was a fixture until removed by a solvent.

A quantity of this raw material being treated with successive portions of carbonbisulphide, there remained, on the filter upon which the residue was thrown, not a yellow powder, but a dark-green and still sticky mass. This was introduced into a flask, and treated with successive portions of hot benzole, until only a black residue consisting of carbon and oxide of iron was left.

The benzole solution was filtered hot, and on cooling deposited a dirty-yellow powder.

Two more crystallizations of this from hot benzole brought it to the state of a clear lemon-yellow powder composed of minute crystalline scales, agreeing with the description of chrysene given by Græbe and Liebermann.

The extraction of the pyrene from the material taken up by the cold carbonbisulphide was, however, a work of far greater difficulty, and its successful accomplishment is entirely due to the unwearied patience and skill of Mr. Wm. E. Geyer, to whom the preparation of both these substances was entrusted.

A quantity of the solution being introduced into a flask, the carbonbisulphide was first distilled off as far as practicable on a water-bath, the last portion, however, being only removable by long exposure in a shallow dish. This was carried on in an outhouse, as the combined odor of this solvent and the tar was eminently offensive.

A portion of the resulting semi-fluid tar was then introduced into a flask of about one litre capacity, which was filled full of 95 per cent. alcohol, and kept in a water-bath at about 170° F., for some hours. The alcoholic solution so obtained was then poured off and distilled for recovery of the alcohol, and the flask above mentioned was filled up with fresh alcohol and heated as before. When this operation had been repeated twice, the alcohol of the subsequent charges was found to deposit on cooling a dirty-green crystalline substance, which was removed by filtration, and, by repeated recrystallizations from hot alcohol, was obtained as a yellow-brown powder, corresponding in its properties with the pyrene of Græbe and Liebermann.

A quantity of the tarry residues from which alcohol had been distilled off, as above, was treated with picric acid, and yielded some picrate of pyrene, which was separated by long draining from much fluid tar and further purified by recrystallization from alcohol

This substance, the picrate of pyrene, crystallizes very readily in long dark-red needles, which are characteristic in their size and the readiness with which they form in a cooling solution.

They are readily decomposed by dilute ammonia, which combines with the picric acid, setting free the pyrene.

This substance, which was examined subsequently to the chrysene, will be more fully described after the optical properties of the other have been given.

The methods used in the study of the fluorescent and absorption bands of these substances were exactly the same as have been already described in connection with my similar examination of anthracene, thallene, and the uranium salts (see this Journal, vol. iii. pp. 81, 162, and 362).

Fluorescent Spectrum of Chrysene.

The fluorescence of chrysene in its solid state, when of the bright yellow color already described, is very strong, resembling in this respect that of chrysogen or of thallene. It is of a vivid yellow-green, and exhibits

* This journal, vol. iii. p. 81.

a spectrum like those of the afore-named bodies, having four blended, broad, bright bands, separated by less bright intervals. The position of these is, however, higher in the spectrum than in chrysogen or thallene, and the upper blue band found in thallene is entirely absent. This last-named point explains exactly the cause of the *yellow*-green color of its general fluorescence as compared with that of thallene.

It had been already observed by Græbe that the yellow color of chrysene was due not to the body itself, but to some associated impurity, and though he was unable to remove this by exposure of the solution to sunlight, as in the case of anthracene, he yet succeeded in procuring a perfectly white chrysene by certain chemical processes, such as the action of a little nitric acid or chromic acid.

In view of the above, the question naturally suggested itself, whether this coloring matter might not be identical with that found in anthracene—in other words, the chrysogen—and, if not, what might be the relation between the two.

To answer this inquiry, it seemed that the only way was to repeat with care the various observations and measurements made upon chrysogen with this yellow chrysene, and then compare the results.

Both the chrysogen found in anthracene and the coloring matter present in chrysene, are too small in quantity and difficult of separation to offer any prospect of a direct isolation and chemical study of these substances.

Beginning then with the fluorescent spectrum of chrysene and comparing it with that of chrysogen as found in impure anthracene, we find that both give similar banded spectra, in which the bands are much blended and are separated not by dark, but by less bright spaces. The bands, four in number, are in color blue-green, emerald-green, orange, and red, the division, however, between the red and orange bands being very faint.

The only difference seems to be that in the chrysene the bands are all a little further towards the violet end of the spectrum than in the chrysogen.

The following measurements will further illustrate this :—

	1st.	2d.	3d.	4th.
Chrysogen in anthracene	41·3	52·4	68·5	82·3
Chrysene (bright yellow)	41·7	55·0	70·5	85·5

Though this displacement, or rather difference of position, is small, it is distinct and unmistakable, and, in connection with the fact that different specimens of anthracene from different parts of the world, if equally freed from grosser impurities, show no such difference of spectra, seems to indicate a specific difference in the coloring matters, to which these fluorescences are due.

In the next place, the effects of solvents on the fluorescence of chrysene were studied and compared.

Here, as with chrysogen and thallene, it was found that the liquids which dissolved even small quantities acquired a rich fluorescence, and that when this fluorescent light was examined with the spectroscope it showed a banded spectrum in which the bands were displaced more or less towards the upper end of the spectrum, according to the nature of the solvent.

The following table will exhibit some of the results in this case.

Spectra of fluorescent light yielded by solutions of chrysene.

Bright band.	1st.	2d.	3d.	4th.	5th.
Solid chrysene	41·7	55·0	70·5	85·5	
Chrysene in chloroform	45·6?	56·4	72·4	92·0	112·9
" " benzole	46·4?	60·3	75·8	92·0	113·7
" " turpentine	47·2	62·8	78·4	95·9	116.4
" " ether	50·3	64·6	78·1	97·1	116·?

We should here notice that in all the solutions an upper bright band (5th) is seen which is not found in the solid substance, under equal or even greatly increased illumination.

When the above measurements are compared with those made some time since on corresponding solutions of impure anthracene, a general and close correspondence is found both as regards the general effect of the various solvents, and the positions of the different lines; without direct comparison, however, it would not be safe to draw more than a general conclusion of similarity from this, as the bands are faint and less defined than in the spectra of the solid substances.

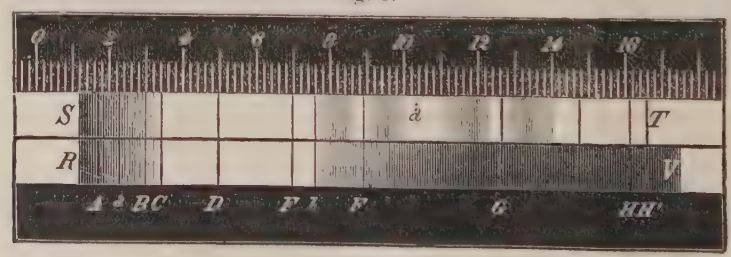
Maxima and Minima of Fluorescence.

When a pure spectrum is thrown upon a screen coated with solid chrysene, maxima of fluorescence are seen at certain parts, just as is the case with chrysogen and thallene.

The accompanying figure will make this clear.

A solar spectrum about an inch broad and seven inches long is thrown on a paper screen and the ad-

Fig. 1.



justments are made until the principal Fraunhofer lines can be readily distinguished.

For the simple paper screen is then substituted one in which the space S T is coated with chrysene.

We then have an appearance such as is indicated in the figure.

At R V is seen the ordinary solar spectrum fading gradually away from a bright orange at D, to an almost invisible violet at V, while above at S T, where the same light falls on the chrysene, we have the upper part of the spectrum almost as bright as the lower, and of a greenish hue, in which we see well defined the Fraunhofer lines, and spaces of special brightness, about F or betwen 8 and 9 of the scale, at a or between 10 and 10·5 of the scale, and about G or between 12 and 12·5, and a portion of yet more vivid green extending from 13 upwards for a distance depending upon the transmitting power of the prism used, for extra violet or actinic rays.

If a strip of paper coated with anthracene rich in chrysogen is placed at R V, the maxima of brightness on this and on the chrysene are seen to correspond in position, but in the case of the chrysogen the spaces between the maxima are much darker than with the chrysene. Otherwise the action is much alike with these two substances, and in both cases the maxima correspond with absorption bands which will be described further on.

When the same pure spectrum is thrown on the side of a rectangular tank, filled with a cold concentrated solution of chrysene in benzole, the appearance presented is that indicated in the accompanying cut.

Fig. 2.

Below F a broad faint illumination of a yellowish-green tint reaches far into the tank. A little above* F is a portion of brilliant green exactly against which comes a blade of darkness extending as it were from the opposite side of the tank, and in fact representing the absorption correlative with the maximum of fluorescence which the bright portion represents.

In other words, the actions which the whole phenomenon involves (as was first shown by Stokes in the case of a solution of chlorophyl) are these.

Light vibrations of the particular wave length which compose this portion of the spectrum are particularly effective in exciting fluorescence in this solution.

They consequently produce a strong action on the solution as they enter it, but just because their energy is converted into this new form, must it be rapidly expended or absorbed. Hence, just these rays which are most active are least able to penetrate into the solution, being used up in producing fluorescent light.

The rays at either side of these, being equally intense, but not so capable of converting their energy into fluorescence, produce less effect, and so travel further into the solution before their power is expended.

Beside the bright spot near F, we find another also of a light-green tint below G, with its corresponding blade of absorption, while another bright region begins above G and extends to the limit of the spectrum, being, however, confined more and more closely to the entering surface as it ascends.

The principal Fraunhofer lines are readily seen in this experiment, as indicated in the cut.

Compared with a similar solution of anthracene containing chrysogen treated in like manner, the chief difference is that the maxima and absorption blades are less sharply defined in the solution of chrysene than in the other substance.

If the solution is diluted, the maxima of fluorescence become less intense, but stretched further into the solution, so pushing back the blades of absorption and thus giving quite a different general effect, although a careful comparison shows the really close relation of the actions.

By a yet further dilution the absorption blades may be lost, or, as it were, driven beyond the further side of the tank, and also losing definition by being more gradual and blended.

The two accompanying cuts, Figs. 3 and 4, taken in connection with Fig. 2, will sufficiently illustrate this point, though they represent a different substance, *i. e.*, thallene.

But while the colors and exact character of bands differ conspicuously in these materials, their general arrangement and actions are precisely similar.

Fig. 3 shows the effect where a weaker solution is used, causing the exciting rays to reach further and to push back the blades of absorption, and Fig. 4 shows a yet weaker solution.

If we employ a solvent in which the substance is less soluble, just such a change as would result from dilution will be observed, though to this in certain cases may be added other modifications, such as an upward

* *I. e.*, to the right of, in cut. Called above because towards the violet or upper end of the spectrum.

displacement of the maxima, or the disappearance of some of them.

Fig. 3.

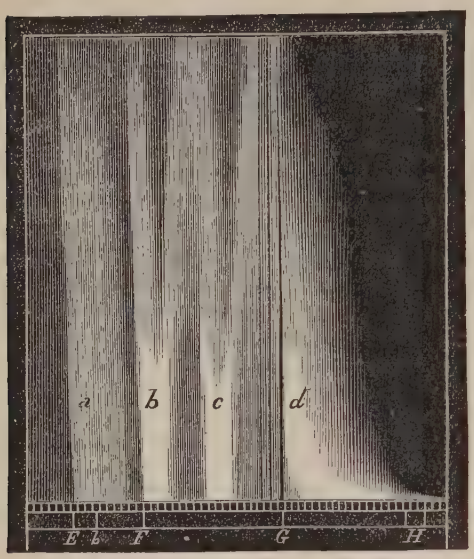
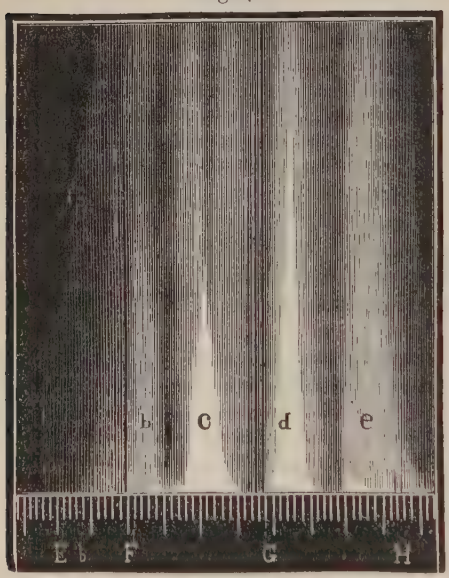


Fig. 4.



Thus while Fig. 3 represents the appearance seen with a solution of thallene in benzole, Fig. 4 is that given by a solution of the same substance in ether. If, however, the latter drawing were to represent a dilute benzole solution of the same, no change would be required except a slight downward displacement of some bands or maxima.

Effects of Solarization.

As we have already noticed, Liebermann found that he was not able by exposure to sunlight to remove the yellow color from chrysene though this method is so effective with anthracene. By greatly intensifying the action, that is to say, by keeping a boiling solution of chrysene in benzole for over thirty minutes in the focus of a lens of 14 inches diameter, we have succeeded in entirely changing the material to which the chrysene owes its yellow color and brilliant fluorescence as above described. The quantity of solution treated at one time was about two fluidounces. On exposing such a hot solution for ten minutes in the focus of the lens, there is deposited a material of a cream color, which shows a very faint fluorescence compared with that of the ordinary yellow chrysene, and whose spectrum of fluorescence is faint and badly defined, but yet indicates an upward displacement of its bands, as appears from the following table:—

Bright bands.	1st.	2d.	3d.	4th.	5th.
Yellow chrysene	41·7	55·	70·5	85·5	
Chrysene solarized 10′	42·1	56·9	73·5	91·0	108·8

A fifth band also makes its appearance in the solarized material as in the solutions, which is not perceptible in the yellow chrysene.

These changes, it may be remarked, are quite similar to those found in thallene (see this journal, vol. iii. p. 164), but I have not found any such action where anthracene containing chrysogen is placed under similar conditions. In that substance the fluorescence of the colored constituent is simply destroyed by the action of sunlight on the hot solution, without any preliminary displacement of bands.

This displacement of bands by solarization in solution, taken in connection with the similar displacement by mere solution in certain liquids, gives a hint at that close relation between solution and chemical action which we have also found more definitely indicated in the reactions of uranic double salts in a like connection (see this journal, vol. iv. p. 3).

Absorption Bands.

If a little yellow chrysene is mixed with melted paraffine and pressed into a thin sheet between two slips of glass, or in any other way reduced to a thin sheet through which light can pass, the transmitted beam will be observed to have certain bands of absorption similar to those seen under like conditions with impure anthracene.

The general absorption of all the upper rays is, however, relatively greater, and thus these bands are the more difficult to recognize and measure.

The various solutions of the same substance, however, show these bands with great clearness, and their positions are given in the following table:—

Absorption bands of chrysogen.

Bands.	1st.	2d.	3d.
Solid chrysene	89·7	105·3	126·7?
Benzole solution	96·3	117·	
Chloroform solution	95·9	116·4	
Ether solution	99·5	121·1	152·8?
Turpentine solution	97·5	119·6	

These bands resemble those given by anthracene and

by thallene in their general character and in their displacement by a change of solvent, but like the bands of fluorescence seem to occupy positions higher in the spectrum, with the exception, perhaps, of the bands of the solid, which hardly appear appreciably different in the case of anthracene and chrysogen.

In conclusion, we would observe that from all the phenomena we are of opinion that the substance to which chrysene owes its color is not identical with that which gives its tint to ordinary anthracene, and described by Fritsche as chrysogen, but is a distinct though closely analogous substance.

(To be continued.)

TELLURIUM MINERALS.

BY A. R. MARVINE,

Of U. S. Geological Survey of the Territories.

The telluride ores, discovered within a few years in the mountains of Colorado, are affording some interesting mineralogical results. Specimens obtained from the Gold Hill mines during the past season by the U. S. Geological Survey of the Territories afforded Dr. Endlish, the Mineralogist of the Survey and of the Smithsonian Institution, the following results:—

Henryite, *n. sp.*—A telluride of lead and iron, with the formula $3PbTe+FeTe$, and containing only 0·25% of silver and no gold. Named after Prof. Joseph Henry, Secretary of the Smithsonian Institution.

Schirmerite, *n. sp.*—Formula (Au, Ag, Fe) Te. Dedicated to Prof. F. L. Schirmer, of Denver City, Director of the U. S. Mint.

Native tellurium is here also found for the first time in Colorado. It occurs in considerable quantity in quartz, and contains 92% tellurium.

COPPER DETERMINATION.

BY J. M. MERRICK, B.SC.

As the readers of the American Chemist know that I have earnestly maintained the excellence of the electrolytic method of determining copper and nickel when it was less in vogue than at present, I may be allowed to translate a passage from Fresenius' *Zeitschrift* for 1874, p. 179, being an extract from Hampe's classical work upon the analysis of crude copper: "Neither the gravimetric or volumetric methods enable us to determine the percentage of pure copper—which is so desirable as a control—with sufficient sharpness. In this respect the electrolytic process alone affords a perfect resource. The extraordinary sharpness and certainty of this method enables the analyst to use 25 grammes of copper for deposition. The results are perfect. The copper determinations have the exactness of the *determinations of an atomic weight*, and present the further advantage that very considerable quantities of crude copper can be employed in the analysis."

Laboratory, 59 Broad St.,
Sept. 24th, 1874.

LABORATORY NOTES. PREPARATION OF PURE CARBONATE OF SODA, PURE CARBONATE OF POTASH, AND ABSOLUTE ALCOHOL.

BY J. LAWRENCE SMITH,

Of Louisville, Kentucky.

From long experience I have found it vain to rely upon manufacturers of chemicals for reagents of that exceeding purity which all analytical chemists often require for conducting their researches, and it has been my habit, through a long experience in analytical chemistry, to prepare with my own hands certain of the chemicals used by me, and, while many of the processes of preparing them embrace nothing specially novel, still my experience in making them has been of certain importance to others, and from time to time I will take opportunities to give more general information of these methods, which may possibly be of service to some, especially as, while seeking first for purity, I have been obliged to economize time by the least amount of manipulation.

Pure Carbonate of Soda.

For many years all the carbonate of soda used by me in mineral analysis has been prepared in the following method, viz., by making oxalate of soda and then decomposing it by heat. It can be described in the shortest possible manner by giving the figures and method employed for obtaining a given result. The carbonate of soda commonly used has been the crystals of ordinary sal soda, washed with a little water to detach the adhering dust, or if one has pure soda at his command it can be used to advantage. The oxalic acid used is the ordinary oxalic acid of the shops once recrystallized, of which recrystallized acid I always have a supply of several pounds in my laboratory.

63 grammes of oxalic acid and 143 grammes of sal soda are dissolved by heat in 200 c. c. m. of distilled water—filter the solutions if necessary—to the solution of soda, when cold, add the solution of oxalic acid, just hot enough to keep from crystallizing; add it by degrees, stirring well; after the mixture is completed, it is expected that the solution will have an alkaline reaction, to keep any trace of soda in solution; the oxalate of soda will be precipitated in great part shortly after the operation is completed; let stand for a short while to cool completely, decant the supernatant liquid, add a little distilled water, break up with a stirrer the lumps of crystals that may have formed, throw on a filter over a Bunsen aspirator, using a six-inch filter, wash with about a half litre of distilled water, and let dry. This may be placed aside in a glass bottle if not needed at once for forming carbonate of soda; the quantity of dry oxalate produced is 30 grammes. To convert into carbonate project the oxalate little by little into a platinum capsule over a good-sized Bunsen burner; after being strongly heated, the oxalate is decomposed into the carbonate, and, if heated high enough to be fused, will furnish about 23 grammes of fused carbonate of soda;

fused or not, dissolve in water, filter, evaporate to dryness, dehydrate over a naked flame, and granulate it by stirring when hot.

Double or quadruple the quantities above given may be operated upon at once with similar results. The carbonate of soda thus made is perfectly free from chlorine, sulphuric acid, silica, or other impurity that will interfere with its use in analysis.

Pure Carbonate of Potash.

It may be wrong to use the word pure in connection with the preparation of this substance in the manner to be described, as it may contain at the end of the operation a trace of nitrate of potash. The starting point is pure nitre, which is a cheap potash salt, and can be readily purified by repeated crystallization; the other is oxalic acid, the commercial acid recrystallized once or twice; 50 grammes of pure nitre and 100 grammes oxalic acid are placed in a platinum capsule; to this is added a small quantity of water, and heated over a gas burner; before the mixture is entirely dry, a second portion of water is added and the heat continued until the mass is brought to dryness, at which time nearly all the nitric acid of the nitre is expelled; the heat is now continued, and the whole mass brought to redness, breaking up the lumps with an iron rod, when the oxalate of potash formed will be decomposed into the carbonate; the mass is treated with water, filtered, dried, and granulated over the flame; this furnishes about 31 grammes of carbonate of potash which, as I have already said, may contain a little nitre, but this in no way interferes with the ordinary use of carbonate of potash in making fusions. For this purpose I commonly mix equal parts of carbonates of soda and potash at the time they are required for use.

Absolute Alcohol.

This substance, as obtained in commerce, very seldom marks more than 98 to 99 per cent. It is, however, not unfrequently made in our laboratories, and when this is done the usual method is employed of pouring strong alcohol on lime until the lumps of lime are covered. This method of proceeding gives a thick magma which, when heated over a water-bath, allows the alcohol to pass over but slowly, and much of the alcohol is lost from the impossibility of the heat penetrating the thick mass. The method I follow differs from this in no way except in the quantity of lime employed; using the smallest quantity of lime necessary to abstract all the water, it is surprising how complete the lime will perform its function in this respect. Take, for instance, one litre of alcohol of 94 per cent.; this contains about 60 grammes of water; if to this be added 120 grammes of good and fresh burnt lime, requiring about 40 grammes of water to convert it into hydrate, actual experiment proves that when kept in contact with the alcohol a sufficient length of time it accomplishes this absorption of water, and the alcohol decanted from the precipitated lime will be fully 98 per cent.

Operating upon this fact, I have been long in the habit of supplying myself with alcohol of 98 and 100 per cent., by proceeding in the following manner: I have in my laboratory three or four two-litre bottles, into each of which I place 1½ litre of 94 per cent. alcohol, the strongest alcohol sold in commerce; to this is added 180 grammes of fresh burnt lime of the best quality broken up into a coarse powder. These bottles are set aside on the shelf and agitated from time to time, the oftener this is done the more rapid will the reaction be accomplished. A week or ten days will usually suffice, when the bottles are allowed to remain at rest and the hydrate of lime will settle in a few days, and by a siphon two-thirds of the original alcohol can be drawn off free from lime, which marks 98 per cent. alcohol, and when filtered and 50 c. c. m. evaporated to dryness there will be left only the merest trace of lime, less than one-half milligramme. But, of course, redistillation is so simple that if we wish the alcohol at 98° it can be readily distilled over a water-bath. The magma remaining in the bottle, when distilled over a water-bath, furnishes the remainder of the alcohol about one-half per cent. higher.

When absolute alcohol is desired, take the alcohol just as it has been siphoned off or distilled from the magma, put it in a convenient flask for distillation, and to each litre add 120 grammes of lime in coarse powder, attach to a Liebig condenser inverted, so that the alcohol will run back into the flask when condensed; this is continued for an hour and a half or two hours. The condenser is then placed in its normal condition and alcohol distilled over which will mark 100 per cent. Recently I have learned that there is a method adopted of making the absolute alcohol by one distillation, operating by the invented condenser first, but in this process the amount of lime called for is the usual quantity, whereas I find that by reducing the lime to its minimum and always having bottles ready to furnish 98 per cent. alcohol, the operation is facilitated, and the loss diminished. So that with the ordinary conveniences and appliances of the laboratory, that are always at hand to be mounted, I can, with fifteen or twenty minutes of *personal attention and manipulation*, obtain a litre or two of absolute alcohol. Of course the time for the reaction of the materials and the distillation is not referred to, as this requires little or no supervision.

JAPANESE COALS.*

BY HENRY S. MUNROE, E.M.,

Assistant Geologist and Mining Engineer, Geological Survey of Hokkiado (Yesso), Japan.

The coals of Japan seem to be of modern origin (according to Mr. Lyman those of Yesso are probably tertiary); but, like the so-called lignites of the Rocky Mountains, they are by no means poor or worthless fuels, but will compare favorably with many coals of true carboniferous age.

* Rewritten and condensed for the American Chemist, from a report made to the Chief Geologist, April 22d, 1874. H. S. M.

Coal has been discovered in at least twenty-five of the sixty-two provinces of Japan, and has been worked quite largely in eight or more of them. In 1871 the *reported* yield was about 170,000 tons (certainly far below the truth), about one-half of which came from Hizen.

On the Island of Yesso coal has been discovered at several localities; but, so far as is now known, exists in valuable quantity at only three points, viz., the Kayanoma, Horumui, and Sorachi fields. The last-named places are on two branches of the Ishikari river, about thirty miles apart, and probably form one and the same field.

The Kayanoma field is situated on the west coast of Yesso (about lat. 43° 10′), and, so far as explored, covers less than a square mile, and has six or more workable seams of coal, from three and a half to eight feet thick. Coal has been mined at two points, "Furushiki" (old mine) and "Honshiki" (new mine). The Furushiki coal is a fat caking coal, of fine quality, solid and lustrous, but containing considerable ash. This coal is not now mined, having been abandoned for the more accessible Honshiki coal. This latter coal was first worked under the direction of Mr. Gower some years ago, but is now under Japanese management.

The Ishikari field (embracing the Horumui and Sorachi fields), according to Mr. Lyman, would seem to be about thirty miles in diameter, only a small portion of which has been surveyed. According to the same authority, there are here four to five workable beds of coal, from three to five feet thick. This coal has not yet been mined.

The samples of coal examined may be divided into four classes, as follows:—

1st. Hand specimens, from Japanese and other sources.

2d. Hand specimens, selected with care, as average samples.

3d. Average samples, representing a few kilogrammes.

4th. Average samples, representing one ton to five hundred tons.

In the first category must be placed the coals numbered in the following tables; 2, 3, 6, 7, and 8 collected at Kayanoma; 37, 41, 42, 43, and 44 from the Bosankioku* collection; 38, a specimen furnished by Admiral Enomoto, and 40, a lignite brought by Mr. Janin. The results obtained from such specimens will usually be rather better than from the average of the coal.

The second class will include coals numbered 26, 27, 28, 29, 30, 32, 33, 35, and 36, specimens of which were collected by the chief geologist.

The third series, numbers 10, 11, 12, 14, 15, 16, 17, 18, 19, 21, 22, 23, and 25, were samples of two to five kilogrammes, taken as nearly as possible in a uniform slice across the bed or bench of coal, omitting only seams of shale or clay. These specimens were sent to Tokei in sealed saki-tubs.* The seals covering 10, 11, 12, 14, and 15 were broken on the way, but the coal in the tubs was apparently undisturbed.

The fourth class, average samples, includes numbers 1, 4, 5, and 9. About one-half ton of each (1, 4, and 9) was mined in my presence, as nearly as possible in a uniform slice across the bed. This coal was brought to the surface, there broken to small pieces, the "slate" picked out, and finally sampled carefully, by repeated quarterings on a clean board floor. The average sample resulting from this treatment was packed in a small tub, and securely sealed.

Sample 5 was taken from a heap of about five hundred tons, mined within the three previous months, and which had been exposed to the weather, unprotected, during part or all of that time. An average half ton or more was secured by taking shovelfuls from different parts of the heap, and sampled as above. These saki-tubs reached Tokei with unbroken seals.

Pulverization, etc.—To prepare the coals of the first and second classes for analysis, a small quantity was chipped from different parts of each specimen, and the resulting samples reduced to a fine powder, sifting through a fine muslin bolting cloth.

The average samples of the third and fourth classes were broken smaller and divided, and one portion of about a kilogramme was pulverized, sifted through a coarse sieve, and again sampled. About fifty grammes of this was reserved for analysis, and powdered as before to pass through a fine bolting cloth.

Assays.—The results of the assays are given in the following tables. The methods employed are not novel, and not always the best; but it was found necessary to adapt the manner of work to the conveniences at hand, preventing sometimes the employment of certain processes altogether. The following is an outline of the method adopted:—

Five grammes of coal were taken in each case, and the *moisture* was determined by the loss upon heating to 140° C., in an atmosphere of carbonic acid. The *volatile combustible matter* was calculated from the loss of the dry coal upon ignition in a covered porcelain crucible, in a closed muffle. For the first five minutes or so, or until the volatile matter ceased to come off, the muffle was kept at a low red heat, and finally raised to a bright red or even white heat for one or two minutes, to expel the last traces of gas. To extinguish the coke, the experiment was tried of plunging the hot crucible into an atmosphere of dry carbonic acid gas, and allowing them to cool there before weighing. This plan gave results 1·5 to 2 per cent. higher† than the usual method, and was therefore adopted for the majority of the assays. The *ash* was obtained by careful incineration of the coke in uncovered crucibles, in an open muffle, requiring from two to eight hours' ignition.

* Department of Production, Government of Yesso.

* Saki, a fermented liquor made from rice. These tubs, of course, were made clean and dry before putting in the samples of coal.

† A part of this increase may be due to an absorption of carbonic acid by the coke.

The ratio of fixed carbon to one of volatile combustible matter, given in the fifth column of the table, is stated by Johnson* to be a very reliable index of the value of the coal.

The color of the ash, column six, presents some points of interest. These ashes were carefully preserved in small specimen tubes, and compared at the close of the investigation. Arranged in the order of succession of the beds of coal, there seems to be a regular shading of the colors, the lighter shades belonging to the lower coals, and the darker to the upper. This is more noticeable in the different benches of each seam† than in the case of the whole series; as the upper bench of one bed is usually darker than the lower bench of the next above. In the Horumui coals this shading of colors is very perfect, forming an unbroken series from the lowest bed to the highest. In the Kayanoma group there are several exceptions, "Furushiki" and "Oukosawa" being the most evident. The true position of these beds is, however, still undecided.

The colors may also be grouped into two classes: bright pure orange-yellows and orange-reds, and dull, dirty, or brownish colors. The former shades belonging to the Horumui and Sorachi coals, and the latter to those of the Kayanoma field.

The calculated percentages of ash in the coke, given in column eight, show the large increase of ash in coking, and point out the necessity for a preparatory washing of these coals.

The terms used in describing the apparent quality of the coke, in column nine, require some explanation. A hard, solid, lustrous, and porous coke is called "excellent;" one hard, solid, and lustrous, but close grained, "very good;" one, again, hard, dense, and lustrous, but fragile, is only "good;" while one soft, fragile, etc. etc., is but "fair," etc.

The specific gravity, column tenth, was determined in a small specific gravity bottle from the weight of water (at 15° C.) displaced by a known quantity of finely-powdered coal. The coal was thoroughly wetted by shaking it in the bottle with a small quantity of water, and afterwards placing the whole under a vacuum for a short time.

Column 11. Weight of one cubic foot of solid coal. Calculated from the specific gravity—taking the weight of one cubic foot of water at 62½ pounds.

Column 12. Space required to stow one ton, of 2240 pounds, of loose and broken coal. This space depends quite as much upon the state of division of the coal; the proportion of slack and of large pieces, as upon the specific gravity; and can hardly be calculated exactly beforehand. Even experimental determinations must be repeated from day to day, upon large quantities of coal, for some time, in order to be of much value. It has been thought better, therefore, to give the space necessary for each coal between limits, than to attempt to form an artificial average. These figures have been calculated from the specific gravity, using constants determined by Johnson.*

In the following tables, on lines 13, 20, 24, etc., will be found averages of the different beds. These averages have been calculated on the supposition that the coal from each bench enters the mixture in proportion to the thickness of that bench. The slight differences in the specific gravity of the various benches were disregarded as unimportant.

The Horumui coals were numbered in the course of the laboratory work, to facilitate reference. The numbers correspond to what has since been given me as the order of succession, beginning, however, with the upper coal.

The Kayanoma coals are also arranged geologically, the upper coal at the top. The coals from other parts of Japan are arranged geographically, beginning with the northernmost.

Small samples of each of these coals were tested practically by burning in an open fire. According to their behavior they may be divided into four classes, as follows; the coals of each class being arranged according to the ratio of fixed carbon to one of volatile matter, the best coals first.

1st. *Fat, caking blacksmith's coals;* Furushiki, Takashima, and Miike coals.

2d. *Caking coals.* Sorachi No. 1, Sorachi No. 2, Honshiki, Horumui No. 5, Horumui No. 3, Midzunuki, Caratsu, Horumui No. 4, Osawa No. 6.

3d. *Free burning, or steam coals;* Funakimura, Tateire, Horumui No. 1, Horumui No. 2, Osawa No. 9, Horumui No. 6, Chatsunai, Hiyamidzu, Ogurasawa, Kosawa No. 4.

4th. *Ligniti;* Kadzuno lignite.

The *Furushiki coal* may be taken as a type of the first class.

Coal bright, black, and lustrous, soft but quite solid. Will bear transportation. Contains thin seams of "slate." Cleavage irregular and laminated, fracture hackly, streak black; powder brown.

Ignites with some difficulty, and burns very slowly with a short, bright flame and considerable smoke. Swells, intumesces, and melts to a soft pasty mass, which chokes the draft and requires continual stirring to keep up the flame. After the flame has ceased there remains a large mass of very porous coke, making a good glowing fire.

Ash, pulverulent, containing some slaty cinder. Coke hard, very lustrous, exceedingly porous, and quite solid. The coal in coking seems to swell about three hundred per cent.! The coke gives a slight smell of sulphur in burning.

The Takashima and Miike coals swell much less in coking; not more than fifty per cent.

* Walter R. Johnson, Coal Trade of North America, Philadelphia, 1850. For a list of these coals arranged according to their ratio see the next column.

† Kosawa No. 4 seems to be the only exception.

* Walter R. Johnson, Report on American Coals, Washington, 1844, page 590, Table CC, column 5.

JAPANESE COALS.

Kayanoma Coals, Yesso.

No.	Name of Coal.	1 Moisture at 140° C.	2 Volatile combustible.	3 Fixed carbon.	4 Ash.	5 Ratio of fixed carb. to vol. comb.	6 Color of ash.	7 Per cent. of coke.	8 Ash to 100 of coke.	9 External appearance of coke.	10 Specific gravity of coal.	11 Wt. of 1 cub. ft. solid.	12 Cub. ft. required to stow 1 ton 2240 lbs. broken.
1	Midzunuki coal, average sample....4·0 ft.	3·73	33·03	41·76	21·48	1·264	Dk. reddish-brown.	63·78	31·95	Good.	1·446	90·38	38 to 46
2	Honshiki coal, upper bench.....6·4 "	5·71	30·94	50·63	3·72	1·268	Light brown.	54·35	6·84	Very good.	1·266	79·09	44 " 52
3	" " lower bench.....1·3 "	5·51	33·39	46·03	14·07	1·379	Light lavender.	69·10	23·41	Fair.	1·340	83·76	41 " 50
4	" " average sample from mine	5·36	35·95	46·11	13·08	1·283	Light brown.	59·19	22·10	Very good.	1·351	84·44	41 " 49
5	" " " from "dump"	4·12	34·88	45·26	15·74	1·298	" "	61·00	25·80	" "	1·363	85·19	41 " 49
6	Tateire No. 2, upper bench.....1·9 ft.	5·63	32·22	40·38	12·77	1·533	Reddish-brown.	None.	—	—	1·355	84·69	41 " 49
7	" " middle bench .....1·1 "	3·43	25·63	36·06	34·86	1·407	White.	"	—	—	1·539	96·19	35 " 43
8	" " lower bench .....6·7 "	5·66	33·68	48·71	11·95	1·417	"	69·66	19·70	Fair.	1·346	84·13	41 " 49
9	" " average sample from mine	5·66	29·93	41·50	23·51	1·386	Brownish-white.	65·01	36·16	Very poor.	1·411	88·20	39 " 47
10	Kosawa No. 4, upper bench.....1·6 ft.	12·98	41·84	38·05	7·13	0·909	Pink.	None.	—	—	1·359	84·94	41 " 49
11	" " middle bench .....1·7 "	12·71	44·97	36·55	5·77	0·813	"	"	—	—	1·367	85·44	40 " 48
12	" " lower bench.....1·6 "	6·19	31·75	44·42	17·64	1·084	Reddish-brown.	"	—	—	1·408	88·00	39 " 47
13	" " calculated average of bed	11·51	41·07	38·73	8·69	0·906	Light brown ?	"	—	—	1·372	83·55	41 " 50
14	Osawa No. 6, upper benches.....3·9 ft.	5·43	41·43	43·36	9·78	1·047	Reddish-brown.	53·14	18·40	Good.	1·286	80·04	43 " 52
15	" " lowest (?) benches...1·5 "	4·85	25·30	29·79	40·06	1·177	White.	None.	—	—	1·589	99·30	35 " 41
16	Osawa No. 9, 6th bench .....1·4 "	6·75	39·03	42·57	11·65	1·091	Light brown.	54·22	21·47	Fair.	1·347	84·19	41 " 49
17	" " 5th " .....1·2 "	5·66	41·47	46·44	6·43	1·120	" "	52·87	12·16	Good.	1·301	81·25	43 " 51
18	" " 4th " .....1·8 "	9·40	38·66	46·47	5·47	1·202	Light ochre.	None.	—	—	1·296	81·00	43 " 51
19	" " 3d " .....1·4 "	9·55	35·80	49·71	4·94	1·388	Pink.	"	—	—	1·316	82·25	42 " 50
20	" " calculated average of bed.	8·03	38·60	46·29	7·08	1·200	Light brown ?	? ?	—	Very poor ?	1·315	82·18	42 " 50
21	Ogurasawa No. 3, upper bench.....2·0 ft.	6·43	35·33	38·44	19·80	1·088	White.	None.	—	—	1·490	87·52	40 " 47
22	" " middle bench ..4·0 "	7·86	35·03	39·28	17·83	1·121	"	"	—	—	1·410	88·15	39 " 47
23	" " lower bench....1·4 "	5·91	36·27	33·98	23·84	0·937	"	"	—	—	1·423	88·88	39 " 46
24	" " calculated average....	7·04	35·37	37·97	19·62	1·074	"	"	—	—	1·410	88·15	39 " 47
25	Furushiki No. 3	1·34	28·44	54·53	15·69	1·914	Lavender.	70·22	22·20	Excellent.	1·326	82·88	42 " 50
26	Chatsunai, Oukosawa No. 1, 5 ft. bench..	10·85	39·63	43·46	6·06	1·097	Reddish-brown.	None.	—	—	1·334	83·38	42 " 50

Ishikari Coals, Yesso.

27	Horumui No 1, 4·2 ft. Marked (L 576 1)	5·62	39·88	52·32	2·18	1·312	Dark umber.	54·50	4·00	Very poor.	1·284	80·25	43 to 52
28	" " 2, 5·0 ft. " (L 602 a)	5·19	37·51	54·84	2·46	1·281	Bright orange.	57·30	4·03	Poor.	1·281	80·06	43 " 52
29	" " 3, 1·9 ft. bench (L 602 ba)	4·20	40·42	51·99	3·39	1·286	Orange-yellow.	55·38	6·12	Good.	1·277	79·80	43 " 52
30	" " 3, 5·6 ft. " "	4·25	41·26	52·08	2·41	1·262	" "	54·49	4·44	Fair.	1·286	83·75	43 " 52
31	" " 3, calculated average.....	4·24	41·01	52·05	2·70	1·269	" "	54·75	4·93	Fair ?	1·283	82·37	43 " 52
32	" " 4, 2·0 ft. bench (L 602 ca)	5·03	38·29	53·31	3·37	1·131	" "	56·68	5·93	Fair.	1·305	81·57	43 " 51
33	" " 4, 2·7 ft. " "	4·58	40·67	50·45	4·30	1·240	" "	54·75	7·85	Good.	1·304	81·52	43 " 51
34	" " 4, calculated average... ..	4·85	39·24	52·17	3·74	1·174	" "	55·90	6·67	Fair.	1·305	81·55	43 " 51
35	" " 5, 5·0 ft. Marked (L 603 e)	4·47	40·80	52·08	2·65	1·276	Yellow.	54·73	4·84	Good.	1·282	80·14	43 " 52
36	" " 6, 4·0 ft. " (L 603 g)	8·48	37·52	51·57	2·43	1·108	"	None.	—	—	1·323	82·69	42 " 50
	Sorachi.												
37	Sorachi No. 1, (Bussankioku collection)..	2·93	35·03	59·05	2·99	1·686	Light yellow.	61·02	4·82	Very good.	1·279	79·74	43 " 52
38	" " No. 2 or 3" (Admiral Enomoto)..	2·89	35·77	59·02	2·32	1·650	Orange-yellow.	61·34	3·78	" "	1·272	79·48	43 " 52

Coal from other Parts of Japan.

	Nippon.												
39	Hiyamidzu coal, Iwaki.....	9·84	38·47	41·52	10·17	1·079	Brownish-white.	None.	—	—	1·380	86·22	40 to 48
40	Lignite, Kadzuno Mines, Akita.....	14·35	27·14	56·08	2·43	2·066	Lavender.	"	—	—	1·338	83·62	41 " 50
41	Gas coal, Miike, Bizen.....	0·54	38·51	43·36	17·59	1·126	Red-brown.	60·96	28·86	Excellent.	1·335	83·44	41 " 50
42	Funakimura coal, Chosiu.....	11·49	33·13	51·44	3·94	1·552	Pink.	None.	—	—	1·337	83·56	41 " 50
	Kiusiu.												
43	Karatsu coal, Hizen	2·69	40·13	47·12	10·01	1·174	Yellow.	57·13	17·50	Very good.	1·349	84·31	41 " 49
44	Takashima coal, Hizen.....	1·32	38·13	55·45	5·10	1·454	Pink.	60·55	8·42	Excellent.	1·260	78·78	44 " 53

Caking coals. The coals of this class range between the fat coals and the free burning or steam coals; the Sorachi coal approaching the character of the first class, while the other coals of the list, coking only imperfectly, resemble the free burning fuel.

As a type of this class we may take Honshiki coal, now mined at Kayanoma.

This coal is black, lustrous, hard, and solid, and will bear handling. Cleavage more or less cubical. Streak dark brown, almost black. Powder very dark brown.

Easily ignited, decrepitates, and for the most part falls to pieces; the lower bench alone retaining its shape. Cements together again after a short time, but not very perfectly. Burns slowly, with a bright flame of medium length, giving but little smoke.

Ash light and powdery, containing a little slaty cinder from the lower bench. Coke very hard, solid and lustrous, but not very porous. Coal shrinks in coking.

The Horumui coals do not decrepitate nor fall to pieces; but burn quietly without cementing.

Osawa No. 6 decrepitates and falls to pieces very badly, but does not cement together again.

Steam coals. Some of these coals coke slightly, but the greater part are non-coking. The Horumui coals may be taken as a type.

These coals behave very much alike in the fire. All ignite with some difficulty, and burn rather slowly, with a bright flame of little more than medium length, giving but little smoke. All crack and open somewhat in burning, but only Nos. 2 and 6 fall to pieces. They do not melt or cement together in the fire. Number one seems to swell a little.

Coke: Numbers one and two give a soft, friable, rather dull and close-grained coke. Numbers, 3, 4, and 5 give a hard and solid coke of medium lustre, but not very porous. That from the lower bench of No. 3 is more friable than the others. Number six does not coke.

Ash, very small quantity, powdery, and rather heavy.

Funakimura, Chatsunai, and Kosawa No. 4 fall to pieces badly in the fire; and as the Tateiri coal contains a very large quantity of ash, the Horumui coals really stand at the head of this class.

The Ogurasawa coal in its appearance, and by its properties, is very much like a cannel coal, and would undoubtedly make a very valuable fuel for open-grate fires.

Kadzuno Ligniti. From the Kadzuno mines in the province of Ougo, Akita Kew, on the northwest coast of Nippon. Black, dull, and soft; with a cubical cleavage. Has a fibrous structure, showing the grain of the original wood; cuts, splits, and breaks like a mass of solid compressed charcoal, and in fact resembles charcoal more than coal. Streak, very black; powder, very dark, almost black.

Lights easily, and burns rather slowly with a short feebly luminous flame. It cracks open in burning, but holds together, only falling to pieces when disturbed. After the flame has ceased there remains a large mass of glowing coals, which yield a slight smell of sulphur in burning.

With a view to determine more exactly the value of these coals as compared with similar fuels from other parts of the world, a few of them have been submitted to ultimate analysis, with the results given in the following table.

Method of Analysis.—The combustion of a weighed sample of dried coal was effected with chromate of lead, in a current of purified air, and in an iron combustion-tube, after Cloëz's process.* The products of combustion were passed through a series of U tubes; one filled with pumice, moistened with sulphuric acid, to absorb the water; and another filled with soda-lime, which absorbed the carbonic acid. Attached to the soda-lime tube was a small sulphuric acid tube, to arrest any moisture taken from the soda-lime by the dry air. The *hydrogen* was calculated from the increase of weight of the first tube, and the *carbon* from the increment of the two latter.

The *sulphur* was determined by fusion with potassium hydrate and potassium nitrate in a silver dish; with precipitation by barium chloride as usual, etc. etc., after Von Liebig's† process. The silica was separated from the solution by evaporation to dryness, etc., before precipitating the sulphur, and the barium sulphate due to the reagents was deducted in each case from the final result.

The *moisture* was determined as before,‡ and the *oxygen* and *nitrogen* found "by difference."

The *combined water* was calculated by adding to the oxygen (assuming the nitrogen at 1·2 per cent.§) one-eighth of its weight of hydrogen. The remainder of the hydrogen is supposed to be available as fuel, and is given in the table under the heading "*free hydrogen.*"

From these results are calculated the calorific powers given in the table. These are expressed in centigrade heat units, and represent the weight of water raised one degree centigrade by one part of fuel.

Calorific Power I. is found by multiplying the percentages of carbon and free hydrogen by their respective calorific powers, 8080 and 34.462.

This result might be approximated in a calorimeter; or wherever the burning of the fuel is complete, and the residues and products of combustion are cooled and made to give up their absorbed and latent heat.

Calorific Power II. is found by deducting from I. the units of heat necessary to vaporize the moisture, combined water, and water of combustion of the fuel. (536·5 units for each unit of water.)

This calculation is made on the supposition, that the products of combustion are cooled only to 100° C., as

* Fresenius, Quantitative Analysis, London, 1865, § 192, p. 506.

† Fresenius, § 181, a, 1, p. 498.

‡ See page 121.

§ The mean amount of nitrogen in eight American lignites having nearly the same composition as these coals.

when the fuel is used for the evaporation of water; and that only the exact amount of air (at 100° C.), necessary to the perfect combustion of the fuel, is supplied to the fire. The initial temperature of the fuel, as well as of the air, is supposed to be 100° C. The figures given in this line will, therefore, express the greatest effect obtainable from the fuel, when used in generating steam.

Weight of water (at 100° C.) evaporated by one part of coal I. Obtained from Calorific Power II. by dividing by 556·5, the units of heat absorbed by one part of water at 100° C. in passing into steam of the same temperature.

This gives the maximum amount of steam that will be produced by one of fuel; or, in other words, the pounds of steam evaporated by the burning of one pound of coal.

Weight of water (at 100° C.) evaporated by one part of coal II. According to Johnson's* experiments the evaporative power of a fuel is independent of the percentage of free hydrogen it may contain.

By taking 7170 for the calorific power of carbon, as given by Dulong, and 572°·2 C. (1030° F.) for the latent heat of steam, as determined by his own researches, he obtained theoretical results from the carbon alone, agreeing almost precisely with the figures given by direct practical experiment. But Dulong's coefficient for carbon is too low, and Johnson's determination of the latent heat of steam is too high, both errors tending to make the calculated results too low; and on recalculating his work with the more recent coefficients, the agreement is by no means remarkable.

The figures in this line are nevertheless calculated with the coefficients used by Johnson, and will probably give figures approximating very closely to actual practice.†

The *temperature of combustion* was found by dividing Calorific Power II. by the heat-units necessary to raise the products of combustion one degree centigrade. The products of combustion were calculated on the supposition, that the carbon burns completely to carbonic acid, the hydrogen to water, and the sulphur to sulphurous oxide. These products, with the hygroscopic and combined water, the nitrogen, and the ash of the fuel, and also the nitrogen of the air necessary for combustion, were multiplied by their respective specific heats, and the sum taken for the divisor mentioned above.‡

This calculation assumes the initial temperature of the air and fuel to be zero degrees, also that only the exact amount of air necessary for combustion is admitted to the fire; and, finally, that the combustion of the fuel is perfect and complete.

* Coal Trade of North America, W. A. Johnson, Philadelphia, 1850, pages 111 *et seq.*

† Johnson's experiments show results ranging from 7·34 to 10·70 lbs. of water evaporated by one pound of coal.

‡ For an example of this method of calculating calorific powers, etc, see Prof. Raymond's paper on the Lignites of the Far West, *Engineering and Mining Journal*, xv. 322.

Ultimate Analyses and Calorific Powers.

	1 Midzunuki coal (mine).	4 Honshiki coal (mine).	5 Honshiki coal (dump).	9 Takeiri coal (mine).	25 Furushiki coal No. 3.	28 Horimui coal No. 2.	36 Horimui coal No. 6.	37 Sorachi coal No. 1.	40 Kadzuno lignite.	41 Mike gas coal.	43 Karasu coal.	44 Takashima coal.	Average of 12 Japanese coals.	Average of 8 American* lignites
Moisture	3·714	5·360	4·095	5·060	1·342	5·194	8·479	2·928	14·346	0·586	2·690	1·320	4·589	10·004
Carbon	57·689	65·221	64·412	56·283	69·049	72·982	68·842	77·940	62·149	69·280	69·436	78·633	67·585	63·531
Hydrogen	4·620	5·222	4·911	4·124	5·256	5·300	4·771	5·685	3·358	5·524	5·756	5·816	4·979	4·492
Oxygen and nitrogen	10·144	10·118	9·940	10·271	7·172	13·841	15·180	11·014	16·395	4·888	11·920	8·721	10·800	16·299†
Sulphur	3·765	1·607	1·449	1·178	2·386	0·353	0·472	0·542	2·116	3·488	1·177	0·659	1·599	1·342
Mineral matter‡	20·068	12·472	15·193	23·084	14·795	2·330	2·256	2·791	1·636	1·234	9·021	4·851	10·448	4·372
Total	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000
Combined water	10·062	10·033	9·832	2·990	6·718	14·221	15·727	11·041	17·994	4·149	12·060	8·461	10·800	16·955
Free hydrogen	3·502	4·107	3·818	2·900	4·510	3·720	3·024	4·458	1·459	5·063	3·816	4·876	3·779	2·268
Calorific Power I.	5868	6654	6521	5577	7133	7179	6604	7782	5525	7342	6927	8035	6764	5895
Calorific Power II.	5625	6373	6262	5351	6872	6895	6349	7492	5286	7072	6664	7747	6499	5644
Weight of water (at 100° C.) evap'd by 1 of coal { I	10·48	11·88	11·67	9·97	12·81	12·85	11·80	13·96	9·85	13·16	12·42	14·44	12·11	10·52
Weight of water (at 100° C.) evap'd by 1 of coal { II	6·78	7·66	7·57	6·63	8·16	8·66	8·11	9·11	7·35	8·16	8·21	9·32	7·98	7·47
Temperature of combustion	2504° C.	2476° C.	2556° C.	2510° C.	2605° C.	2578° C.	2531° C.	2627° C.	2374° C.	2613° C.	2581° C.	2644° C.	2566° C.	2473° C.

* Analyses made by the writer some four years ago—see *Engineering and Mining Journal*, vol. xv., p. 322.

† Including nitrogen 1·228.

‡ Mineral matter equals ash minus oxygen absorbed by iron of pyrites, equal to three-eighths of the sulphur.

It will, perhaps, be interesting to compare these coals with fuels from other parts of the world. For this purpose I have taken the following table from Percy's Metallurgy,* making a few interpolations. For convenience in comparison, the analyses are calculated for 100 of carbon, and arranged according to the amount of oxygen; beginning with wood, and ending with the most perfect coal—anthracite:—

	Carbon.	Hydrogen.	Oxygen.
1. Wood (mean of 26 analyses)	100·00	12·18	83·07
2. Peat	100·00	9·85	55·76
(*a*) Lignite† (average 22 varieties)	100·00	8·52	44·73
3. Lignite (average 15 varieties)	100·00	8·87	42·42
(*b*) Lignite or brown coal‡ (average 9)	100·00	8·33	32·03
(*c*) American lignites§ (average 8 varieties)	100·00	6·46	23·72
4. Ten Yard coal, S. Staffordshire, England	100·00	6·12	21·23
5. Steam coal, Tyne, England	100·00	5·91	18·32
(*d*) "Block" coal, Ind., U. S.	100·00	6·17	16·13
(*e*) Japanese coal (average)	100·00	7·37	15·95
(*f*) Sorachi coal (Yesso)	100·00	7·37	14·30
(*g*) Caking coals, England (average 8)	100·00	6·72	10 91
(*h*) Furushiki coal (Yesso)	100·00	7·61	10·24
6. Anthracite, S. Wales, England	100·00	4·75	5·28
7. Anthracite, Penna., U. S.	100·00	2·84	1·74

It will be seen on inspecting this table, that these Japanese coals are widely removed by their composition from all coals of similar age, and can be compared with the best carboniferous coals. They are, therefore, neither *lignites* nor *brown coals*, but true *bituminous coals*.

This result is certainly quite remarkable, inasmuch as these coals are supposed to be of modern origin.

MISCELLANEOUS CHEMICAL NOTES.

BY S. DANA HAYES,
State Assayer for Massachusetts.

VIII. Adulterations in Alcoholic Liquors.

I have been surprised to see an article printed in some of the journals of popular science, in which the author speaks disparagingly of the value of chemical analysis in detecting adulterations in alcoholic liquors. I think it is to be regretted that such a statement should have been promulgated as this, taken from the article referred to, "None but an experienced wine taster can detect the difference" between "British brandy and genuine brandy." Certainly the author should come under old Dr. Cramer's ban, of writing "like one who never blacked his fingers or singed his beard in (laboratory) metallic operations."

It may be said, with truth, that no methods of chemical analysis are so perfect as to be beyond improvement and criticism, but they afford unquestionable results when employed for determining the presence or absence of constituents in nearly all the substances that ordinarily come into the chemist's hands for examination. In the analysis of waters, for instance, there are many excellent methods for the analyst to select from, and some of them so exact as to determine the presence of nitrogenous impurities in the water of a mountain stream, and also in that of a city well; but no careful analytical chemist could make the mistake of declaring that the difference between such waters cannot be distinguished by analysis. And again, in the analysis of adulterated milk, the determination of the percentage of water "intentionally added," may not be exactly accomplished by the modes of procedure in common use in the laboratory; and the standard milk selected for comparison by different chemists may not be the same always. Nevertheless the value and accuracy of milk analyses is generally recognized and seldom questioned, although a practised judgment must be exercised when conclusions are to be drawn from the numerical data obtained at the balance in these analyses. And so in analyzing alcoholic liquors, the chemists who have been called upon to do much of this work do not meet with great difficulties in detecting the impurities and adulterations commonly used; but the work requires careful preparation and experience.

It is not my intention to give, in detail, in this note, the methods of analysis which have been found most valuable for the examination of liquors in this laboratory. They are necessarily varied with the different kinds of liquors—many of them of curious composition—that are brought here in very considerable numbers by the operation of the peculiar laws of this commonwealth. I may be able, however, to give in a few lines such directions as will enable others to satisfy themselves in the laboratory that adulterated alcoholic liquors may be successfully analyzed.

The preliminary examination, in which the color, odor, density, odor after dilution with water and with weak alkaline water, and its changes in a few hours, comparison with standard specimens, etc., are carefully noted, is always instructive, and sometimes affords such evidence of the presence of adulterating substances as to shorten the analysis very much. It is true that these tests are not strictly chemical processes, but this should not deter the chemist, who is in pursuit of information, from making use of them, any more than he would neglect to observe the physical characters, such as structure, crystalline form, density, and color of minerals and solid bodies, before making the chemical analysis.

After this preliminary examination, the distillations, evaporations, and direct tests with reagents are made, nearly in the manner described in the works of Thudichum and Dupré, Griffin, Duplais, and elsewhere. Especial analysis is made of the first distillates, by absorption, redistillations, and direct tests with reagents, which seldom fails to yield results from which it may be

* Die Metallurgie, von John Percy, M.D., F.R.S., Braunschweig, 1863, 1 Bd. s. 98.

† From Austria, Saxony, Prussia, Russia, etc.

‡ From France, Germany, Austria, Greece, etc.

§ See note, Table III. From California, Oregon, Alaska, Utah, and Wyoming, U. S.

decided whether or not the original liquor has been flavored with oils, essences, and ethers; the difference in volatility between added ethers and those naturally present being quite distinguishable. Then the relative weight and full analysis of the solid residues determines the presence of other impurities. If complete analysis of this kind be made of a liquor of known purity, in comparison with the analysis of the suspected sample, extremely accurate and reliable results may be obtained.

In preparing for such work, it is important to get standard specimens of known value, representing as many different kinds of liquors as possible, and these should be obtained directly from the manufacturers and distillers, or from original packages in the custom houses. A knowledge of the composition of these standards and the modes of their manufacture, is also an essential part of the preparation; and further, as many experimental analyses as possible should be made of imitation liquors of known composition, such as are produced by following the directions given in different "receipts." With these auxiliaries, which are not difficult to obtain, it seems improbable that any skilled chemist would confuse the mixed and adulterated alcoholic liquors, often sold by retail dealers, with those of standard quality and purity.

French brandy is the kind of liquor most frequently mentioned as presenting the greatest difficulties to the analytical chemist, and there is abundance of evidence that it does not often reach the consumer in the same condition that it leaves the distiller. But a little inquiry reveals the fact that comparatively few kinds of brandy are imported to this country, and these may be represented by ten or twelve of the standard samples to be used for comparative analyses and tests. If fictitious brandies, made by any of the "receipts" now so common in books and newspapers, or if the so-called "British brandy" be analyzed in comparison with these standards, the differences will be found quite as distinct and positive as between pure and impure water, or watered and unwatered milk.

The methods of analysis, of which I have given the merest outline, may seem, from this description, to be tedious and complicated; but they have not been found so in practice. The work is interesting, and quite a number of analyses may be carried along together. At another time I hope to treat this subject more thoroughly and completely, and I will only add now, that the metals copper and lead, derived from the apparatus used, are much more commonly present, in small quantities, in distilled spirits which may be pure in other respects, than is generally supposed. They are seldom entirely absent, and should always be sought for and determined by analysis.

IX. Commercial Glue.

During the progress of a recent investigation, I observed some chemical characters of commercial glue, that I believe have not been previously described.

Analyses of two samples of white glue, of the best grade, yielded the following results:—

	"No. 1 extra C." glue.	Frozen glue.
Moisture (loss of weight at 100° C.)	16·70	16·28
Gelatine, with a little animal fibre and fats	79·85	80·42
Carbonate of lime	1·42	1·33
Sulphate of lime	0·41	0·34
Phosphate of magnesia	0·35	0·31
Alkaline salts	0·17	0·12
Silica, oxide of iron, etc.	0·09	0·08
Oxide of zinc,	1·01	1·12
Total	100·	100·

Analyses of ten more samples of frozen and sheet glue, of common grades and from different makers, showed the proportion of water contained in them to vary from fourteen to eighteen per cent., averaging seventeen per cent. And the proportion of ash or mineral matter varied from three to six per cent., averaging rather less than four per cent. Two of these samples contained about one per cent. of white zinc, and two of them contained sulphate of lime.

Analyses of two samples of commercial gelatine averaged sixteen and a half per cent. of water, and 2·56 and 3·11 per cent. of ash, respectively. There was no oxide of zinc or sulphate of lime in these gelatines.

The presence of so much water was quite unexpected, and as the quantity is nearly the same in fresh and in seasoned specimens, it is not a make-weight, although steam is very freely used in the rooms where glue is packed by the manufacturers. The carbonate of lime comes from the quicklime used for cleaning and preserving the animal matter, or "glue-stock," while the sulphate of lime is formed by the addition of small quantities of sulphuric acid during the process of manufacture, to neutralize the lime that is carried forward by the solutions of glue. The oxide of zinc is said to be added to "prevent souring," or the acidity caused by decomposition, and it also improves the color of the glue; but it is not very generally used, as these analyses indicate. I have heard of the use of sulphate of zinc, alum, magnesia, etc., by glue-makers, but I did not find any other substance than those named above in these specimens, which represented the article commonly sold and used.

The impure glues, or those containing the most mineral matter, became almost insoluble after they had been broken into small pieces and heated in a hot air-bath (copper oven) at 100° C., for two or three hours, until they cease to lose weight; they then soften and become dough-like, but do not dissolve when boiled in water for some time. The purer gelatines were not so much injured, and one specimen, containing only 2·56 per cent. of ash, was not materially affected by this thorough drying. The solid sheet glue, while drying in this way, tumefied, and became very porous; the frozen glue did not alter in structure.

The conclusion drawn from these experiments was, that the excess of lime combines with the gelatine and perhaps with the extraneous animal matters of the glue, at the high temperature, forming a compound like lime-soap, as the whole quantity of lime is retained in the insoluble portion left after boiling the dried glue in water. Such an explanation accounts for the difference noticed in the effect of drying upon gelatine and common glue.

No. 4 State Street, Boston, Sept. 25, 1874.

NOTE ON THE DETERMINATION OF INDIGOTINE WITH HYDROSULPHITE OF SODA.

BY A. MÜLLER.

Translated by Elwyn Waller, E.M.

Starting from the property of sodic hydrosulphite of decolorizing a sulphuric acid solution of indigotine, by transforming that body into white indigo, I have essayed, by the advice of M. Schutzenberger, to apply this process to the titration of indigoes. Before describing the apparatus serving for this titration I will give the preparation of the *hydrosulphite*.

In a bottle with a wide neck with a capacity of about 150 c. c. place cuttings or sheets of zinc rolled on themselves, the bottle being full, pour into it a concentrated solution of sodic bisulphite; after three-quarters of an hour to an hour, the reaction is ended. The contents of the bottle are then poured into a vial, and agitated with 50 to 60 grammes of lime recently slaked; dilute with 5 to 6 litres of water, and filter. This is the liquid which serves for titering. The sodic hydrosulphite absorbing the oxygen of the air with considerable facility, it is necessary to effect the titration in an atmosphere of inert gas (carbonic acid or hydrogen). For this purpose a Mohr burette with a long discharge tube is taken, the discharge tube being fitted to the centre of a cork having three holes for tubes, which cork is adapted to a flask of about 200 c. c. capacity; the two other tubes serve the one for the introduction of the gas by a tube running to the bottom of the flask, the other for its exit, by a tube which conducts it into a vessel of water in such a way that the gas disengages bubbles through this liquid. The inert gas is furnished by a continuous apparatus, in such a way that the current may be regulated at will. The bottle containing the hydrosulphite solution from which one draws, in proportion as it is wanted, is of a capacity of 1 to 2 litres; it should be well stoppered with a caoutchouc stopper pierced with two holes. In one of these is a tube terminating in the upper portion of the bottle and communicating with a source of inert gas (in this case illuminating gas might be used), the other receives a tube running to the bottom of the bottle, and terminated by a rubber tube. These two tubes are closed when one is not drawing off the hydrosulphite. To fill the burette the free end of the latter tube is connected with the discharge tube of the burette, and the liquid is aspirated into it by means of another tube fixed by means of a cork to the upper part of the burette.

Titration of the Sodic Hydrosulphite.—An ammoniacal solution of copper sulphate is decolorized by the hydrosulphite; under these conditions cuprous oxide forms which remains dissolved in the excess of ammonia; under the same conditions the indigotine alters to white indigo. I have found that to decolorize a molecule of cupric sulphate, exactly the same volume of hydrosulphite is required as to decolorize a molecule of pure indigotine. These reactions are, therefore, very clear, and prove that the process employed is exact.*

We may formulate these reactions in the following manner:—

$$2CuSO_4 + H_2 + H_2 + H_2O = Cu_2O + 2H_2SO_4$$
$$2(C_8H_5NO) + H_2 = C_{16}H_{12}N_2O_2$$

In considering the molecular weight of each of these bodies we find that one gramme of pure indigotine is decolorized by the same volume of hydrosulphite as 1·904 grms. pure crystallized cupric sulphate. To make the normal solution, we therefore take 1·904 grms. pure crystallized cupric sulphate, which we dissolve in water, and, after adding an excess of ammonia, dilute with water to a litre. To standardize the hydrosulphite we take 50 c. c. of this solution, which is run into the flask with the three tubulures, and, after having passed the gas rapidly for about thirty seconds, the current is slackened, and the hydrosulphite is run in to complete decolorization.

Determination of the Indigotine.—Draw off 50 c. c. of the sulphuric acid solution, containing one gramme of indigo, in the litre; boil in a small flask to drive out the air dissolved; run it into the flask with three tubulures, pass the gas through at first rapidly for thirty seconds, then more slowly, running in the hydrosulphite until the tint of the liquid passes from a yellow-green to a yellow, more or less light, according to the purity of the indigo employed. With indigoes of inferior quality, the liquid must be diluted with an equal volume of water to render the final tint sufficiently marked.

Let us suppose that in this titration we have used 14·3 c. c. to completely decolorize the 50 c. c. of the indigo solution; knowing, on the other hand, that to decolorize completely the same volume of cupric solution we had required 20·6 c. c., to find the contents in indigotine of the indigo analyzed we would make the proportion—

$$20{\cdot}6 : 100 :: 14{\cdot}3 : x;$$ from which $x = 69{\cdot}4$.

The following indigoes have been titred by this process:—

	Indigotine per cent.
Bengal	69·4
Guatemala	60·3
Kurpali	51·6
Indigotine	100·0

—*Bulletin de la Société Industrelle de Mulhouse*, January, 1874.

CHEMISTRY APPLIED TO THE DETECTION OF ADULTERATION.

BY ALFRED H. ALLEN, F.C.S.,

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In accordance with the request of the Editor of the Chemical News, I have undertaken the compilation of

* In a report on this method to the Society at the session of August 27, 1873 (published in the Bulletin of November and December, 1873), Dr. F. Goppelsroeder, who, in connection with MM. Leonard and Trechsel, made experiments on the accuracy of this process, though commending it highly, is strongly adverse to this mode of standardizing the hydrosulphite solution, inasmuch as with the cupric solution very varying results were obtained, disagreeing with one another by from four to fifteen per cent. Experiments with a solution of potassic permanganate, containing 1·576 grms. in a litre, gave very constant results. Dr. G. therefore recommends standardizing with permanganate, and suggests that even a better agent for this purpose may be found.

a series of articles on the detection and estimation of adulteration of food, etc., regarded more especially from a chemical point of view.

The microscopical examination of food has been dealt with so fully by Hassall, and by Mr. Bell in his recent lecture before the Chemical Society, that there is no occasion to enter into the matter again, especially as the microscopic appearance of substances is not liable to change or improvement, like the chemical processes for their detection and estimation.

The very great want of definite knowledge on the subject, and of a more systematic method of procedure, has doubtless been the cause of some of the recent lamentable discrepancies in the results of public analysts, and there seems to be a demand on the part of many chemists for further information respecting the processes adopted by their fellow analysts.

In the following articles I propose to give, in a condensed form, the results of previous workers, and in some instances to supplement these by the conclusions derived from my own observation and experience. Of course the articles must be largely compiled from former papers, but it is hoped that they will be found more useful and convenient than a continual reference to the originals.

I. Coffee and Chicory.

Coffee and chicory can be conveniently considered together, as their adulterations are to a great extent similar, and the frequency of their admixture renders it difficult to treat of either without reference to the other

It is a very prevalent idea that the admixture of chicory with coffee is a decided improvement, and *de gustibus non est disputandum;* but the low price of chicory as compared with coffee is a strong temptation to increase the proportion of chicory to an undue extent. Certainly, the unacknowledged addition of chicory to coffee must be considered an adulteration, but there can be no objection to the mixture being sold, provided the purchaser does not purchase it for pure coffee.

Chicory (*Chycorium intybus*) belongs to an entirely different botanical order from coffee, being closely allied to *Taraxacum* (dandelion), which it resembles in its therapeutic effects. Chicory is entirely destitute of the alkaloid caffeine, of caffeic acid, and of the essential and fixed oil contained in coffee (a little fat is added to chicory during the process of roasting), and appears to possess no stimulating or other valuable dietetic properties.

The infusion of coffee is brown, but perfectly clear, and strikingly different in appearance from that given by chicory, which is turbid and of a disagreeable bitter flavor. It seems probable that coffee drinkers, who like the dark color and bitter taste which an admixture of chicory imparts, might obtain the same results in a cheaper, and possibly healthier way, by using burnt sugar, which is said to be sold to coffee dealers and coffee house keepers under the name of "black-jack."

Good coffee is not hygroscopic, while chicory is highly so, and mixtures containing it show the same character more or less. Squeezed between the fingers, genuine coffee does not cohere, but mixtures containing chicory usually cake together. When moistened with water, the grains of coffee remain hard for a considerable time, while the usual adulterants soften immediately.

A *preliminary examination* of coffee for admixture is best made by gently strewing the powder upon the surface of cold water. The oil contained in coffee prevents the particles from being readily wetted by the water, thus causing them to float. Chicory, burnt sugar, etc., contain no oil, and their caramel is very quickly extracted by the water, with production of a brown color, while the particles themselves rapidly sink to the bottom of the water.* On stirring the liquid, coffee becomes tolerably uniformly diffused without sensibly coloring the water, while chicory and other sweet roots quickly give a dark brown turbid infusion. Roasted cereals do not give so distinct a color.

Under the microscope, the presence of chicory is readily recognized by the peculiar dotted character of the vessels, often occurring in bundles, and by the characteristic appearance of the large cells. The presence of burnt sugar is best recognized by moistening the sample with water, and observing it with a low power. If the brown coloration appears to be concentrated round small, dark-colored, hard, shiny particles, the presence of extraneous caramel may be considered certain. Chicory and other roasted sweet roots contain caramel as a normal constituent, so the chemical tests are valueless for indicating its origin.

If roasted cereals or leguminous seeds be present, the starch corpuscles will still be recognizable, though often so altered as to render it impossible to determine the kind of seed from which they were derived.

The microscope affords an efficient means of detecting most of the adulterants of coffee and chicory, but for their estimation recourse must be had to other means, and even these are not very satisfactory, the determinations possible by known methods amounting at best to mere approximations.

According to Messrs. Graham, Stenhouse, and Campbell,† the proportion of sugar existing in raw and roasted coffee berries is:—

	Sugar, per cent.	
	Raw.	Roasted.
Highest amount	7·78	1·14
Lowest amount	5·73	—
Average of twelve specimens grown in different places	6·97	0·26

The sugar in the raw berries is cane sugar, but it appears to exist in some peculiar state of combination, as it does not yield caramel by the roasting of the berries.

The percentage of sugar in chicory and other sweet roots has also been determined by the above chemists (by fermentation).

	Sugar, per cent.	
	Raw.	Roasted.
Foreign chicory	23·76	11·98
Guernsey "	30.49	15·96
English "	35·23	17·98
" " (Yorkshire)	32·06	9·86
Mangold-wurzel	23.68	9·96
Carrots (ordinary)	31·98	11·53
Turnips	30·48	9·65
Beet-root (red)	24.06	17·24
Dandelion-root	21.96	9·08
Parsnips	21·70	6·98

Messrs. Graham, Stenhouse, and Campbell found that the depth of color of the liquid obtained by infusing coffee and its usual adulterants in 2000 times their weight of boiling water varied remarkably, caramel

* If a separating funnel be used for the above test, the chicory, etc. may be readily let out at the lower end and examined separately under the microscope.

† Journ. Chem. Soc., 1857, p. 33.

giving about seven times, and chicory about three times, as deep a color as coffee. The test, in my opinion, is of but limited value, as coffee itself gives a brown color, and therefore a moderate adulteration cannot be detected, especially as different samples of coffee were found to vary between 183 and 143 in tinctorial power, as compared with caramel at 1000.

Caramel itself is not a definite substance, and different samples vary much in tinctorial power.

Messrs. Graham, Stenhouse, and Campbell found the density of infusions of coffee and its adulterants a valuable criterion. The solutions were made by treating the powder of the roasted substance with ten times its weight of cold water, and then raising the liquid to the boiling-point and filtering through paper, when the infusions had the following densities at 60° F.

Spent tan	1002·14
Lupin-seed	1005·70
Acorns	1007·30
Peas	1007·30
Mocha coffee	1008·00
Beans	1008·40
Neilgherry coffee	1008·40
Plantation Ceylon coffee	1008·70
Java coffee	1008 70
Jamaica coffee	1008.70
Costa Rica coffee	1009·00
" "	1009·05
Native Ceylon coffee	1009·00
Brown malt	1010·90
Parsnips	1014·30
Carrots	1017.10
Bouka	1018·50
Yorkshire chicory	1019·10
Black malt	1021·20
Turnips	1021·40
Rye-meal	1021·60
English chicory	1021·70
Dandelion-root	1021·90
Red beet	1022·10
Foreign chicory	1022·60
Guernsey chicory	1023·20
Mangold-wurzel	1023·50
Maize	1025·30
Bread raspings	1026·30

This test furnishes valuable confirmatory evidence of the presence and probable proportion of sweet roots and cereals, but does not allow the recognition of the leguminous seeds.

Neither chicory nor coffee contains starch, so, if any be present, it shows an admixture with some cereal or leguminous seed. If the sample be boiled with water and animal charcoal, starch may readily be detected in the cold filtered solution by the well-known blue coloration with solution of iodine.

Of course, the particular seed which has been added to the sample can only be ascertained with certainty when the process of roasting has left the microscopic characters of the starch almost unchanged, but when the adulteration is extensive, valuable confirmatory evidence is afforded by the composition of the ash, as pointed out by Messrs. Graham, Stenhouse, and Campbell in the paper already referred to.

The percentage of ash yielded by genuine coffee should not exceed 4·5 per cent., and chicory should not give more than 5 per cent. of ash, and any proportion considerably in excess of these numbers may be regarded as indicating adulteration by mineral matter. If red ochre, Venetian red, or other ferruginous matter be present, the ash will have a reddish color. The oxide of iron natural to coffee never reaches 1 per cent. of the weight of the ash, and in chicory ash it varies from 3 to over 5 per cent.

The ash of coffee is remarkable for its almost complete freedom from silica, so that, even if 1 per cent. of the ash remains insoluble in boiling hydrochloric acid, it is a proof of adulteration. Chicory ash, on the other hand, contains a large and very variable amount of silica, varying from 10 to 36 per cent. of its weight. A considerable proportion of this exists in the form of actual sand; this will be left insoluble on treatment of the ash with hydrochloric acid, but, to render the whole of the silica insoluble, evaporation of the acid liquid to dryness, and re-solution, must be resorted to. Iron can be conveniently determined in the filtrate by one of the volumetric methods. A considerable quantity of the sample should be taken when it is intended to make these estimations.

Some years ago imitation coffee berries were manufactured of Stourbridge clay; these were mixed with the genuine berries, and roasted with them, when they absorbed some of the coloring matter and oil, and so remained a close imitation. On breaking such spurious berries, the color would be seen to be principally on the exterior. Of course the fraud would be at once detected on the estimation of the ash and its contained silica.

In 1850, Messrs. Duckworth, of Liverpool, took out a patent for moulding chicory into the form of berries.

As a rule I should recommend the use of the following method of examining coffee and chicory, the first three tests being always applied, and the others when further information is required:—

1. The cold-water test.
2. Examination of the sediment in cold water, and of the original sample, under the microscope.
3. Estimation of the ash and, if necessary, of its contained silica and iron.
4. Determination of the density of the aqueous infusion.
5. Ebullition of the sample with water and animal charcoal, and application of the iodine-test for starch to the filtered liquid when cold.

The ash of coffee showing a remarkable constancy of composition, it occurred to me that the percentage of ash soluble in water would be a valuable criterion of the purity of any sample of coffee, and afford a simple and ready means of approximately estimating the percentage of chicory present. Of course more experiments are required before the method can be depended on, but it appears the most promising of any, as its accuracy would be unaffected by variations in the process of roasting.

I ignited three samples of genuine coffee of different kinds, and three of chicory, taking 5 grms. for each experiment. After weighing, the ash was boiled in water, the liquid filtered, the clear solution evaporated to dryness, and the residue heated to dull redness and weighed. The following were the proportions in 100 of the sample:—

	Total Ash.	Soluble Ash.		
1. Coffee	3·86	2·95 = 76	per cent of total ash	
2. "	3·95	3·40 = 86	"	"
3. "	4·20	3·38 = 80	"	"
Average of coffees	4·00	3·24 = 81	"	"

1. Chicory (foreign)	5·36	1·20	= 22	per cent. of total ash	
2. " "	5·05	1·83	= 36	"	"
3. " (English)	4·90	2·18	= 44	"	"
Average of chicories	5·06	1·74	= 34	"	"

The proportion the soluble ash of the chicories bears to the total varies considerably, owing to the different quantities of silica present in the samples, and the percentage of soluble ash is not so constant as in the case of coffee.

Assuming 3·24 per cent. as the average soluble ash of coffee, and 1·74 as that of chicory, the percentage of coffee in a mixture would be represented by the following equation, where C is the percentage of coffee, and S the percentage of soluble ash:—

$$C = \frac{(100\,S - 174)2}{3}.$$

The following are the determinations of Messrs. Graham, Stenhouse, and Campbell, of the coloring powers of coffee and its different adulterants, when roasted and infused in equal quantities of water. No attempt appears to have been made to exhaust the samples.

Caramel	1000
Mangold-wurzel	602
Bouka (a coffee substitute)	602
Black malt	549
White turnips	500
Carrots	500
Chicory (darkest Yorkshire)	450
Parsnips	400
Maize	350
Rye	350
Dandelion root	300
Red beet	300
Bread raspings	275
Acorns	200
Over-roasted coffee	183
Highly-roasted coffee	173
Medium-roasted coffee	144
Another specimen coffee	150
White lupin seed	100
Peas	73
Beans	75
Spent tan	30
Brown malt	25

Though the method of Messrs. Graham, Stenhouse, and Campbell is objectionable, for reasons previously stated, I have found the color of the infusion gives a very fair approximate estimate of the proportion of chicory present when the following modified process is adopted: Instead of caramel I employ, as a standard of comparison, a mixture of various kinds of coffee with an equal weight of mixed chicory.

Mixed chicory gives almost exactly three times as strong a color as the average coffee, and separate samples of chicory do not vary more than from 2·8 to 3·2 in coloring power, when compared with the same sample of coffee.

One gramme of the standard mixture of equal parts of coffee and chicory, and the same weight of the sample to be tested, are boiled for a few minutes with 20 c.c. of water. The liquids are cooled, and passed through a double filter, the insoluble portion being repeatedly boiled with fresh quantities of water until exhausted. The solution of the standard mixture is then made up with water to 200 c.c., and the solution of the sample to 100 c.c. 10 c.c. of the latter liquid are poured into a narrow Binks's burette, and some of the standard solution into a test-tube of exactly equal bore. If the sample consists of pure coffee the two liquids will now be of exactly similar tint, but if chicory be present the liquid in the burette will be the darker, in which case water is added till the tints are precisely equal. (The tints are best observed by placing a piece of wet filter-paper behind the tubes while they are held up to the light.) When this point is attained, the volume of the liquid in the burette is observed. Each c.c. of water added corresponds to 5 per cent. of chicory in the sample. Thus, if the liquid in the burette measures 17 c.c., the sample contains 35 per cent. of chicory.

From the density of a solution of a sample of mixed chicory and coffee, prepared as described on page 130, the proportions can be readily calculated by the following formula, in which C represents the percentage of coffee in the mixture, and D is the density of the solution:—

$$C = \frac{(1020{\cdot}6 - D)100}{12}.$$

My own estimations of the density of pure coffee infusions have given a mean of 1008·7, closely agreeing with the determinations of Messrs. Graham, Stenhouse, and Campbell, but I found the infusions of chicory often had as high a density as 1025.

It will be seen that the proportions of coffee and chicory, in mixtures of the two, can be approximately ascertained by the amount of soluble ash, by the color of the infusion, and by the density of a solution of 1 part in 10 of water. With substances of definite composition one method would be sufficient, but with articles of so variable a nature as coffee and chicory an analyst would be very unwise to rely on the indications afforded by any method taken singly. When the different determinations are approximately concordant, the proportion of chicory may be considered proved. Of course it is not necessary to examine every sample fully, but when the microscope and the cold-water test have proved the presence of chicory it is very desirable to ascertain the proportion in which it exists. When the coffee contains other adulterants as well, the problem becomes too complicated for solution in the present state of the subject.

Infusions of coffee and chicory are quickly and completely decolorized by potassium permanganate. I have taken advantage of this fact for ascertaining the presence of starch in coffee and chicory. The following method is preferable to that in which animal charcoal is employed: The sample is boiled for a few minutes with water, and, *when cool*, the liquid is acidified with sulphuric acid, and permanganate added till the color of the solution is destroyed. The clear liquid is then decanted or strained away from the insoluble matter, and tested for starch with solution of iodine. The well-known blue coloration is produced if the sample was adulterated with any cereal or leguminous seed, and the intensity of the tint affords a rough idea of the extent to which the adulteration was practised. As this test only occupies a few minutes, and a negative result by it proves the absence of a large class of adulterants, it will often save the trouble of a tedious examination under the microscope.

The insoluble matter remaining after treatment with permanganate, etc., can be advantageously examined under the microscope, the peculiar structure of chicory,

etc., being more readily observed on account of the removal of the coloring matter.

The most common adulterants of chicory and coffee are caramel, locust beans, acorns, rye, maize, mangold-wurzel, and carrots, but the use of most of these admixtures has been almost abandoned since the New Adulteration Act came into operation.

II. Tea.

Until recently, the methods of detecting the adulteration of tea were in a very unsatisfactory condition, but the subject has been very successfully studied during the past year, and there is now no important adulteration of tea which cannot be detected with proper care.

Tea is commonly divided into the two great classes, of green and black. It is now well proved that the difference in the color is dependent on the method of preparation, and not on any difference in the nature of the plant. Thus the Darjeeling Tea Company are now preparing as green tea the leaves from the same plants of which they have hitherto manufactured black tea.

The soil on which the tea is grown, the climate, the time at which the leaves are gathered, and the details of the manufacture, all affect the *quality* of the tea, regarded as a commercial article, but they fortunately have but little effect on its composition. On this account, the analyses of genuine teas (when performed in the same way) show a remarkable constancy of composition, and it would be impossible to tell uniformly from the analytical results which teas would command the highest price. This fact is of great importance, for, while any extensive adulteration is rendered apparent from the analysis, there is little danger of mistaking an inferior tea for an adulterated one.

The most valuable constituent of tea, from a dietetic point of view, is undoubtedly the alkaloid *theine*, and it is also the most variable, the amount present in genuine teas ranging from 1·9 to 5·8 per cent. (Bell). On this account, its determination is valueless as a criterion of adulteration, though of primary importance when forming an opinion on the *quality* of a tea. No doubt tea-tasters are greatly guided by the amount of theine (ascertained by the taste), though the essential oil, bouquet, tannin, and color of the infusion also furnish them with valuable information.

Of the commercial value of a tea, of course a tea-taster is the best judge, but the following facts clearly prove that he is not always competent to judge of the presence of certain adulterants, especially exhausted leaves, which merely tend to produce a general weakening of the tea without appreciably altering its bouquet, flavor, etc. Some teas give much darker infusions than others, so that adulteration cannot be recognized by this character alone.

I purchased a pound of black tea at 2*s.* 6*d.*, and infused a portion of it, using fresh quantities of water, till scarcely any further color was obtained. The exhausted leaves were re-dried, broken up, and mixed in various proportions with the original tea. The adulterated teas thus obtained were then taken to a professed tea-taster, who liquored them in my presence. He understood that some of the samples contained exhausted leaves, the presence of which was more or less disguised, but I told him that the tea was free from sandy or magnetic matter, foreign leaves, etc.

	Conclusion.
No. 1. Contained 30 per cent. of exhausted leaves.	Tasted "washed out," no doubt from presence of exhausted leaves.
No. 2. Tea in original condition.	Genuine.
No. 3. Original tea, somewhat crushed.	Mixed with exhausted leaves!
No. 4. Contained 20 per cent. exhausted leaves, a little Na_2CO_3 having been added during the re-drying.	Genuine; better tea than No. 3!
No. 5. Contained 20 per cent. exhausted leaves, and a little catechu.	A washed-out tea, to which some astringent matter had been added.

Although Nos. 2 and 3 were exactly the same tea, the taster failed to recognize their identity by the taste, and actually classed an adulterated tea as superior in flavor to the broken genuine tea.

The adulterations of tea may be conveniently arranged under four heads—1. Mineral additions used for increasing weight or bulk. 2. Organic additions used for increasing weight or bulk. 3. Adulterants used for imparting fictitious strength. 4. Facings and coloring materials.

1. *Mineral Adulterations Used for Increasing Weight or Bulk.*

These are—Magnetic matters, such as magnetic iron ore, and lumps and filings of iron; and siliceous matter, as sand, fragments of quartz, etc.

Magnetic Matter is best detected by pounding a known weight of the tea (10 grms.), and placing it on a sheet of smooth paper. A magnet or electro-magnet is applied to the under side of the paper, and moved laterally, with its poles in contact with the paper. Any magnetic matter is thus readily drawn out and separated from the tea; the use of the magnet should be continued till nothing more follows it. The magnetic matter is next boiled with water for a few minutes to detach adherent organic particles, and the water is then decanted. The residue is next weighed, and then examined under the microscope as an opaque object. If it consists of magnetic oxide or titanate of iron, crystalline facets will probably be apparent, the bulk of the object having a jet-black color. Occasionally, though very rarely, metallic iron is present. This is distinguished from the minerals by the action of moderately concentrated nitric acid (1·2), which dissolves it, with production of red fumes, but does not affect the native compounds. Metallic iron is also distinguished by its power of precipitating metallic copper when warmed with an acidulated solution of cupric sulphate. The weighing of the matter actually extracted by a magnet is far more satisfactory than the estimation of the iron existing in the tea. Tea naturally contains a small proportion of iron as ferric phosphate, but it only amounts to about 3 per cent. of the weight of the ash (calculated as Fe), or to about 0·18 per cent. of the whole tea. Of course this is not affected by a magnet, the use of which has the additional advantage of extracting the extraneous iron in the state in which it naturally exists, and allows of its production in court for the enlightenment of sceptical magistrates.

Caper teas are very frequently adulterated with magnetic matter, sometimes to the extent of 7 or 8 per cent. Many tea-dealers habitually employ the magnet, the use of which is well known to the trade.

Siliceous Matter is readily detected and estimated. Commence by igniting 2 or 3 grms. of the tea in a platinum crucible till all organic matter is consumed, and then weighing the ash. The percentage of this at once indicates the presence or absence of extraneous

siliceous matter, provided no magnetic matter is present. The ash of genuine tea varies from 5·24 to 6·00 per cent. Owing to the presence of steatite in the facing of some green teas (especially gunpowder), the ash of these sometimes reaches nearly 8 per cent.

For the estimation of the amount of extraneous silica, the ash should be well boiled with water, and the liquid filtered (the proportion of soluble ash being a valuable criterion of the presence of exhausted leaves). The residue is washed off the filter (or the paper ignited), and boiled with concentrated hydrochloric acid. The extraneous silica, consisting of quartzose particles and insoluble silicates, is left undissolved, and after collection on a filter, washing, and ignition, it may be weighed. The highest recorded amount of ash insoluble in hydrochloric acid occurring in a genuine unfaced tea is 0·82 per cent. (Wilson), the average being about 0·30 per cent.

"Caper tea" is the kind most frequently adulterated with silicious matter, the amount added sometimes reaching 15 or 20 per cent. Of nineteen Canton capers recently examined by Dr. Hassall, the sandy matter varied from 2·09 to 12·83 per cent. I have not met with so high an amount as the latter figure, but 8 and 10 per cent. of this adulterant are common.

Frequently the silica exists in the form of quartz fragments of very sensible size. Tea-dealers are well aware of the existence of this adulteration, and of the class of teas most subject to it, and they know that, if present, they will see the sand, etc., at the bottom of the vessel in which the tea is infused.

If desired, the iron can be estimated in the hydrochloric acid solution of the ash by one of the volumetric methods.

2. Organic Adulterations Used for Increasing Weight and Bulk.

These are—Exhausted tea-leaves; and leaves other than those of the tea-plant. The chemical methods for the detection of these adulterants are much the same, but in the latter case we have also the botanical characters of the leaf to rely on, and these are sufficiently definite to enable us to form an opinion quite independently of the analytical results.

Exhausted Tea-Leaves are leaves which have been previously infused in water, and then re-dried, with or without addition of gum or starch.

It is evident that the effect of infusing tea-leaves in water is to extract the greater part of the soluble constituents of the tea, and that the re-dried leaves will have a widely different composition from the original tea.

The two principal constituents extracted from tea by hot water are tannin and gum—more or less coloring matter, soluble salts, theine, etc., being also dissolved.

Tannin.—Of the soluble constituents, the tannin is by far the most important and constant, but unfortunately until recently the methods of estimating its amount were very unsatisfactory, the whole of the soluble extract, after allowing for the gum, having sometimes been called tannin. I believe I was the first to use a more satisfactory method of determining the tannin in tea, my process being essentially a precipitation by a standard solution of gelatin.* Although the method has since been employed by Hassall, Bell, and other chemists, I have recently been led to abandon it, on account of the tedious nature of the process, the trouble of re-setting the gelatin solution, and the occasional anomalous results, which defied all attempts to ascertain their cause.

A very valuable method of estimating tannin has recently been described by Mr. Charles Estcourt,* who seems to have succeeded in determining the relative amount of tannic and gallic acids in tea. But while fully appreciating the scientific value of Mr. Estcourt's results, it seems to me that the separate determination of the tannic and gallic acids is a needless trouble and a complication of the methods of detecting tea adulteration. It also seems probable that a portion of the tannic acid may be converted into gallic acid by the prolonged boiling in water necessary for the thorough exhaustion of the tea, and on this account a method which will estimate the total amount of astringent matter, without distinction of its nature, is preferable to a process that gives merely the amount of tannin, while ignoring the gallic acid.

Black tea differs from green tea in the method of its manufacture, the leaves being allowed to undergo a kind of fermentation when black tea is to be produced. During this fermentation, a portion of the tannin becomes altered, with production of dark-colored insoluble matters, so that black tea is found to contain a higher percentage of insoluble matter and a lower percentage of tannin than green tea, the sum of the two constituents being moderately constant. By the process of fermentation, the remaining tannin undergoes a curious change, for the tincture of green tea precipitates tincture of ferric chloride bluish-black, like nut-galls, while the tincture of black tea gives a green color with iron, just as catechu does. If excess of ammonia be added to either colored liquid, a soluble oxidation-product is formed of a deep red color. Other oxidizing agents may be substituted for the ferric chloride, potassium ferricyanide being the most convenient.

If a solution of tannin or an infusion of tea be treated with a strongly ammoniacal solution of potassium ferricyanide, a deep red liquid is obtained, the depth of color being a fair indication of the amount of tannin present. This reaction is exceedingly delicate, $\frac{1}{100}$ milligrm. of tannin being recognizable by it. This is considerably beyond the range of delicacy of the dark coloration produced by iron salts.

When an infusion of tea is precipitated by gelatin in excess, the red coloration is still produced in the filtrate, so that the reaction cannot be used as a color-test for the end of the precipitation by gelatin, but, if a solution of lead acetate be substituted for the gelatin, an insoluble precipitate of mixed tannate and gallate of lead is thrown down, and no color is produced in the filtrate on addition of ammoniacal ferricyanide.

Upon these facts, my assistant, Mr. F. W. Fletcher, has founded a process for the estimation of the astringent matters (tannin, etc.) in tea, and we have used it with the greatest success during the past six months in the examination of upwards of a hundred specimens. The details of the process will follow, and I can confidently recommend it as a most rapid and satisfactory method deserving of general use It is necessary to adhere to the proportions of fluid operated upon, and it must be borne in mind that tannate of lead is not insoluble in free acetic acid unless the solution is sufficiently diluted.

Since the first part of this article was printed, I have

* Full details of this process will be found in the "Pharmaceutical Journal" for Oct. 25, 1873, and in the "Year-Book of Pharmacy," 1873.

* Chemical News, vol. xxix p. 109.

submitted the same set of samples of purposely adulterated tea (described on page 132) to another tea-taster of great experience, who formed the following opinions as to their purity:—

No. 1.—Very poor; contained many exhausted leaves. Ranked 5th.

No. 2.—Passed pure. Ranked 1st.

No. 3.—Would have been the best, but lacks strength, and is, therefore, suggestive of exhausted leaves. Ranked 3d.

No. 4.—Not pure, but very slightly adulterated by exhausted leaves. Ranked 4th.

No. 5.—Passed pure, and ranked 2d.

Estimation of Tannin, etc., by Lead.—Five grammes of lead acetate are dissolved in water and diluted to 1 litre, and the solution filtered after standing. The indicator is made by dissolving 5 milligrammes of pure potassium ferricyanide in 5 c.c. of water, and adding an equal bulk of strong ammonia solution. One drop of this test will detect 0·001 milligrm. of tannin, or 1 milligrm. dissolved in 100 c.c. of water.

The precipitating power of the lead solution is ascertained by diluting 10 c.c. of it to about 100 c.c. with boiling water, and adding to it, from a burette, a solution of 0·1 grm. of pure tannin in 100 c.c. of water. After adding 10 c.c. of the latter solution, about 1 c.c. of the liquid is withdrawn with a pipette and passed through a small filter, the drops being allowed to fall upon spots of the indicating solution previously placed on a porcelain slab. If no pink coloration is observed, another small addition of the tannin solution is made, a small portion of the liquid filtered, and added to the indicator as before, the process being repeated until a pink color is observed. The greatest delicacy is obtained when the drops of liquid from the funnel are allowed to fall directly upon the spots of indicator, instead of observing the point of junction of the liquids.

The reaction being complete, a second estimation is made, and in this case almost the full volume of tannin solution can be added at once.

It is necessary to use the purest tannin for the purpose; as a serious error may otherwise occur, some samples of commercial tannin having little more than half the precipitating power of the best.

Exactly the same process is employed for estimating the tannin in tea, the decoction being substituted for the standard tannin solution and added to the lead solution as before.

The solution of tea is prepared by boiling 2 grms. of the finely-powdered sample with about 80 c.c. of water for half an hour. The decoction is strained through fine muslin, the particles of leaf returned to the flask, and the boiling resumed for an hour with the same quantity of water as before. The process is repeated till no more coloring matter is extracted. The whole of the solution is set aside, to allow any particles that may have passed through the muslin to subside, when the liquid is decanted from the sediment, the last portions passed through a filter, and the whole decoction made up to 250 c.c. This diluted solution is ready for use in the burette, the remainder of the process only occupying a few minutes.

The volume of tannin, or tea solution, it is necessary to add to 100 c.c. of pure water, in order that a drop may give the pink reaction with the ferricyanide, is subtracted from the total amount run from the burette.

If the solutions are made of the strength here described, 10 c.c. of the lead solution will precipitate about 10 milligrms. of pure gallotannic acid, and therefore the volume of tea solution added contains 0·01 grm. of tannin.

If all the weights and volumes above mentioned are observed, 125, divided by the number of c.c. of tea solution used, will give the percentage of tannin, etc., in the sample.

We have ascertained that prolonged boiling does not affect the precipitating power of the tea, and solutions of the same sample prepared on different occasions have given absolutely concordant or closely agreeing results. The percentage of tannin in tea can be ascertained by this process to within 0·2 per cent.

The results obtained by this method agree fairly with those recently obtained by Mr. Bell by the gelatin process, as will be seen from the following figures:—

Tannin in Genuine Black Tea.

	By Gelatin. (Bell.) Per cent.	By Lead. (Allen.) Per cent.
Highest amount	12·00	11·6
Lowest amount	9·50	8·5
Average of 8 samples . . .	10 97	—
Average of 28 samples . . .	—	10·0

Even after infusion tea-leaves still retain a sensible quantity of tannin, which varies from 1 to 4 per cent. according to the extent of the previous treatment. The usual amount is about 3 per cent. Taking the tannin in fresh tea at 10 per cent., and in exhausted leaves at 2 per cent., the extent to which a sample is adulterated would be found approximately by the following equation, in which E is the percentage of exhausted leaves, and T the percentage of tannin found:—

$$E = \frac{(10 - T)\ 100}{8}$$

We have not examined many green teas by the lead method. The tannin found in general specimens varies considerably, 20 per cent. being about the usual amount. The estimation is of less importance than with black tea, as green tea is very unlikely to be adulterated either with exhausted leaves or foreign tannin matters.

Insoluble Matter.—When tea in its commercial condition is boiled repeatedly in fresh quantities of water till the liquid no longer becomes colored, the residual leaves, when thoroughly dried, weigh about 50 per cent. of the original tea, if green, and about 60 per cent. if black. A very large number of estimations of insoluble matter have been recorded, and in no case has a genuine tea yielded a higher percentage than 60·12, which was obtained by Mr. J. Bell from an inferior congou tea. In the accompanying tables I give a number of analyses of genuine teas, from which it is evident that the proportion of insoluble matter is very constant, even in teas of very different qualities.

Having noticed that in broken teas the insoluble matter was sensibly less than in unbroken, we tried the effect of exhaustion by repeated boiling with water on various genuine teas previously reduced to powder. By this method the percentage of insoluble residue is still more constant, but about 8 to 10 per cent. lower in each case than is obtained by treatment of the whole leaves. Thus genuine green teas gave an average of 42·0 per cent., the highest amount being 45·0 per cent., and the lowest 39·0 per cent. In black teas the lowest gave 46·7 per cent., and the highest 53·6 per cent., the average of thirteen samples being 49·0 per cent.

It is impossible to insist too strongly on the importance of estimating the insoluble matter on the *pounded* tea, not on the whole leaves, for not only is the soluble portion more readily and completely extracted, but the

serious error involved in the examination of broken teas is avoided, and the results obtained from such samples can be fairly compared with the rest.

The insoluble matter is most conveniently estimated by drying the residue left after filtration of the tannin solution at about 120° C. till the weight is constant. When the process is repeated on the same tea, the results agree extremely closely with the previous estimation, rarely showing a difference of 0·5 per cent.

The estimation of insoluble matter is of great importance as a means of forming an opinion as to the presence or absence of exhausted leaves.

The percentage of insoluble matter contained in previously infused black tea leaves, after being air dried, varies from 78 to 85 per cent. These results are upon the whole leaves. When the estimation is made on the previously pounded tea the insoluble matter varies between 72 and 75 per cent.

Gum.—It is occasionally desirable to estimate the percentage of gum in tea. Infusion in water of course removes most of the gum. Caper teas and exhausted leaves often contain excess, owing to an addition of gum during their preparation. The gum is determined by evaporating the aqueous decoction of the tea almost to an extract, treating the residue with methylated spirit, and filtering and washing with spirit. The gum is rinsed off the filter with hot water, and the solution evaporated at a steam-heat, and the residue weighed, ignited, and weighed again. The loss represents the gum. If the ignition is omitted the results are too high, owing to the presence of mineral matter.

Soluble Ash.—The percentage of ash soluble in water is also a valuable independent indication of the presence of exhausted and foreign leaves. In the following table I give the percentage of soluble ash contained in a number of samples of genuine tea in exhausted tea-leaves, and in the dried leaves of various other plants :—

	Total Ash.	Soluble Ash.	Authority.
Coffee leaves	10·32	3·77	A. H. Allen.
Beech	4·52	2·00	J. A. Wanklyn.
Bramble	4·53	1·84	" "
Raspberry	7·84	1·72	" "
Hawthorn	8·05	3·78	" "
Willow	9·34	4·16	" "
Plum	9·90	5·66	" "
Elder	10·67	3·19	" "
Gooseberry	13·50	7·83	" "
Common tea	5·92	3·55	" "
Paraguay tea	6·28	4·22	" "
Average of seven teas	5·75	—	" "
Average of nine teas of commerce.	5·66	3·00	A. S. Wilson.
*Horniman's pure black	5·30	3·50	A. H. Allen.
* " " green	5·60	3·80	" "
*"Ambrosial" black tea.	5·60	3·40	" "
*Genuine black at 2*s.* 6*d.*	5·60	3·09	" "
* " " "	5·70	3·28	" "
* " " "	6·02	3·26	" "
* " " "	6·34	3·20	" "
* " " "	6·10	3·96	" "
* " " "	5·75	3·06	" "
* " " at 3*s.*	5·50	3·55	" "
Broken leaf with stalks	5·40	2.80	" "
Caper (containing 4·8 siliceous matter).	11.40	1·50	" "
Mixed dry exhausted leaves from various teas.	4·30	0·52	" "

The soluble ash is determined by evaporating the aqueous solution of the ash, and *gently* igniting the residue, which must be cooled under a desiccator. The mean total ash of the teas marked with an asterisk comes to 5·75 (the same as Wanklyn's mean), and the soluble ash to 3·34, and it will be seen that the latter constituent is scarcely ever below 3·00, while exhausted tea-leaves contain only 4·3 of total and 0·52 of soluble ash. When no foreign leaves are present we are therefore fully justified in calculating the probable proportion of exhausted leaves by the following formula, in which E is the percentage of exhausted leaves, and S the percentage of soluble ash :—

$$E = (6 - 2S)\,20.$$

Of course the result can only be considered as an approximation to the truth, but when the proportions of soluble ash, tannin, and insoluble matter agree in proving the presence of previously exhausted leaves, a very fair conclusion can be arrived at as to the extent to which the adulteration had been practised.

Foreign Leaves.—In the recognition of the presence of leaves other than those of the tea-plant, chemistry cannot be expected to play a very active part, though it may sometimes be made of service for obtaining an approximate estimation of the admixture. For this purpose, the percentage of ash, and the proportion the soluble bears to the total ash, are almost the only points on which there are at present sufficient data to be of use.

A specimen of *sloe-leaves* gathered early in September gave, after drying, the following results :—

	Per cent.	
Moisture	6·40	
Insoluble matter (on whole leaves)	55·90	
Tannin (by gelatin)	16·00	
Gum	8·90	
Ash soluble in water	4·70	8·74
Ash insoluble in water	4·04	

The above analysis shows a composition intermediate between black and green tea, except with respect to the ash, which is considerably higher than that present in tea.

Young sloe-leaves contain very little astringent matter.

For the detection of foreign leaves the botanical and microscopical characters are best fitted. Some of the sample to be examined is put into hot water, and when the leaves have unfolded they are spread out on a glass plate and held up to the light, when the venation, serration, etc., are readily observed. The primary venation of the tea-leaf forms a series of well-defined loops, which are not met with in most leaves used as adulterants. The serrations are not mere saw-teeth on the margin of the leaf, but actual hooks. The serration stops short somewhat abruptly at some distance from the base. The Assam tea-leaf is sometimes bi-serrate. At the apex of the tea-leaf there is a distinct notch, instead of a point.

If the under surface of the tea-leaf be examined under the microscope after the separation of the cuticle, the peculiar and characteristic space between the two cells of the stomata is readily perceived. The long unicellular hairs of the tea-leaf are also peculiar. The employment of caustic potash is desirable in observing these characters.

In the sloe-leaf the serratures are direct incisions, numerous, often irregular, and extending to the base. There are no spines. The hairs are shorter and coarser

than those of the tea-leaf, and are marked in a peculiar manner.

The elder-leaf is more pointed than that of the tea-plant, and the lobes are unequal at the base. The serratures are direct incisions. The midriff has hairs on it, and on the leaf itself there are several kinds of hairs, notably a short spinous striated hair which occurs on the upper surface.

The serratures of the willow-leaf much resemble those of tea, but the cell-walls of both the upper and under epidermis differ from those of the tea-leaf in not being sinuous, and there are long coarse striated hairs. When perfect, the elongated form of the willow-leaf sufficiently distinguishes it from tea, and the venation is also entirely different.

The chief foreign leaves added by the Chinese are those of *Chloranthus inconspicuus* and of *Camellia sasanqua*, the latter of which presents a close resemblance to the tea-plant.

3. *Adulterants Used for Imparting a Fictitious Strength.*

These are—Extraneous Tannin Matters, such as catechu; Lie-tea; Soluble Salts of Iron; and possibly Alkaline Carbonates.

Extraneous Tannin Matters, when used in excess, will be indicated by an abnormally high percentage of tannin. The lead process has a decided advantage in this respect, a sample of brown catechu apparently containing 119 per cent of tannin when examined by this method. This anomalous result is, of course, due to the different precipitating power possessed by the acids of catechu, but the consequence in practice would be that a tea containing a very small percentage of catechu in addition to its normal tannin would give a very high result with lead.

In the case of lie and caper-teas the astringency is often very high, owing to an admixture of extraneous tannin matters.

Strong infusions of genuine teas, with the exception of some kinds from India, are quite clear, and do not become muddy on cooling, Tea adulterated with catechu gives an infusion which quickly becomes turbid on cooling.

Under the microscope catechu may often be recognized by its structure, and by the presence of acicular crystals.

I have made many attempts to discover a means of detecting catechu in tea by its chemical reactions, and may give the following tests, which are tolerably reliable, but should always be applied to the suspected tea side by side with a genuine specimen: One gramme of the pure and the same quantity of the suspected tea are infused in 100 c. c. of water, strained away from the leaves, and precipitated while boiling with a slight excess of neutral lead acetate. The filtered solutions exhibit the following characteristic differences. About 20 c. c. of the solution of pure tea, when treated with a few drops of argentic nitrate (avoiding excess) and cautiously heated, gives but a very slight grayish cloudiness, or precipitate of reduced silver; but the same tea containing 2 per cent. of catechu (purposely added) gives a copious brownish precipitate, the liquid acquiring a distinctly yellowish tinge.

When the proportion of catechu is somewhat larger, the filtrate from the lead precipitate gives a bright green color on adding one drop of dilute ferric chloride, while the solution of pure tea gives only a slight reddish color, due to the presence of acetate. On allowing this liquid to stand, the adulterated tea gives a precipitate of a grayish or olive-green color, the pure tea solution undergoing no change.

These tests, which depend on the properties of catechuic acid, and which answer with caper-tea, together with the estimated proportion of astringent matters and the microscopic characters, render the detection of any considerable addition of catechu tolerably certain; but I doubt the possibility of detecting it when present in only small proportion.

Catechu is sometimes added to tea in a separate state, to impart additional "roughness," or to cover the presence of exhausted leaves, but the adulteration is usually made in the form of "lie-tea" or of "caper."

Lie-Tea consists of the dust of tea or other leaves mixed with clay, sand, iron ore, etc., and made into irregular masses by means of gum or starch. It is said sometimes to contain even less desirable ingredients, such as "pig's dung," and though such statements must be taken *cum grano salis*, there are one or two facts within my own knowledge which certainly point in that direction. Probably the truth is that the "lie-tea" is composed of the general sweepings of the manufactories, and, if so, its nature will vary according to circumstances.

Lie-tea when put into hot water disintegrates and falls to powder, in consequence of the solution of the gum or starch used for procuring the adhesion of the other materials. The iodine-test for starch may be applied to the liquid after acidifying with sulphuric acid and decolorizing with permanganate. The ash of lie-tea is often as high as 30 or 40 per cent.

Caper-Tea is the name given to tea which has been made up into little glossy masses by the aid of gum (or starch). That from the Canton district is invariably adulterated with sandy and magnetic matter, and often with extraneous astringents. It is often largely mixed with foreign leaves. I have never myself met with a caper-tea free from one or more of the above adulterants, and I am in possession of a letter from one of the best-known tea-firms in England, stating that "there is not a specimen of genuine caper-tea in the world."

The insoluble matter in caper and lie-tea is very variable, but usually considerably less than is present in genuine tea. The gum in caper-tea often amounts to 15 or 20 per cent. The soluble ash is often less than 2 per cent.

Soluble Iron Salts are sometimes added to tea to give an appearance of strength, by the formation of dark-colored tannate of iron. They may be detected by shaking the powdered leaves with cold dilute acetic acid, decanting or filtering, and testing the liquid for iron by means of potassium ferrocyanide. By proceeding in this manner, there is no confusion between iron added as a soluble salt (probably as ferrous sulphate) and the ferric phosphate occurring as a natural constituent of the leaf.

Alkaline Carbonates may occasionally be added to tea, as they have the property of increasing the amount of coloring matter extracted on infusion, besides deepening the color of the solution, even after the leaves are separated. It will be remembered that the addition of a small quantity of sodium carbonate during the re-drying of exhausted leaves prevented their detection by a professed tea-taster, who classed the tea containing 20 per cent. of this adulterant as superior to the same tea in a genuine state but somewhat crushed. The presence of sodium carbonate will be at once detected by the persistent yellow flame produced when the soluble ash is

heated on platinum wire. The presence of extraneous potassium carbonate would be detected by estimation of the alkalinity of the soluble ash. According to Zöller, the total amount of potash in the ash of genuine tea is 39·22 per cent., and that of soda 0·65 per cent. A number of genuine teas recently examined by Mr. G. W. Wigner showed, on titration of the aqueous solution of the ash with standard acid, an alkalinity (calculated as K_2O) varying from 1·36 to 1·88 per cent. of the weight of the tea, the average potash of twenty samples being 1·62 per cent.*

All experiments on the ash of tea concur in showing that it is moderately constant in quantity and composition, not exhibiting the extreme variation noticed in the ash of beech-leaves.†

4. *Facings and Coloring Materials.*

It is well known that till recently green tea was almost invariably "faced," the object being to impart a hue demanded by custom, but not naturally possessed by the tea-leaf.‡

Sometimes coloring matters have been used extensively for transforming black tea of low quality into superior green. Except in cases of this kind, where there is a direct fraud on the purchaser by giving the tea a fictitious appearance of value, it seems doubtful how far the facing of tea can be considered an adulteration, as it does not add appreciably to the weight of the article, and few will contend that the facing renders a tea injurious to health.

If a portion of the tea is observed under the microscope as an opaque object, the nature of the materials used in the facing may often be recognized at once. When a faced tea is treated with warm water, the coloring matters become detached, and the small portions rising to the surface may be floated upon a glass slide, and at once examined under a microscope, while the bulk of the facing is obtained as a sediment when the strained liquid is allowed to stand. This deposit often has a distinctly greenish color, from the presence of prussian-blue or indigo. The latter of these is best recognized by the microscope; but the mineral pigment is detected by warming the tea with caustic alkali, filtering, strongly acidifying the filtrate with hydrochloric acid, filtering again if necessary, and testing the clear liquid for ferrocyanide with ferric chloride. On treating the sediment with the alkali it is sure to turn brown, but this must not be taken as a proof of the presence of prussian-blue. The residue left after treatment with the caustic alkali should be treated with hydrochloric acid, and the insoluble portion washed, ignited, and fused with alkaline carbonate. In the product, silica is separated by solution in hydrochloric acid, evaporation to dryness, and re-solution in weak acid, the filtrate precipitated by ammonia and ammonium oxalate, and the liquid filtered from this precipitate tested for magnesium by sodium phosphate. Its detection here proves the presence of *steatite* or other *magnesium silicate*, the use of which gives the tea a peculiar smooth appearance and slippery feel.

Arsenite of copper, chrome yellow, and Dutch pink are also said to have been used as facings. Calcium sulphate is often employed.

Turmeric has been detected by some observers, but I have never met with it myself, the yellow coloring matter being generally of a ferruginous nature.

Caper-tea is often glazed with graphite.—*Chemical News.*

(To be continued.)

* Mr. Wigner has also estimated the total and soluble ash in a large number of teas, and his average results are in remarkably close accordance with those given on page 190. Thus the average total ash of twenty-four samples was 5·66 per cent., and the soluble ash 3·01 per cent. The lowest amount of soluble ash found by Mr. Wigner in a tea known to be genuine was 2·75 per cent., and the highest 3·35 per cent.—*Pharm. Journ.*, May 16, 1874.

† "Journ. Chem. Soc.," 1874, p. 490.

‡ It is a fact well known to the trade that a certain firm of tea-merchants use some method of removing the facing after the arrival of the colored tea in this country.

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS.

In the preparation of these abstracts the Editors are assisted by the following chemists:—

M. Alsberg, Ph.D.,	J. P. Kimball, Ph.D.,
Prof. G. F. Barker,	Louis H. Laudy,
T. M. Blossom, E.M.,	J. M. Merrick, B.Sc.,
H. C. Bolton, Ph.D.,	H. Newton, E.M.,
G. C. Caldwell, Ph.D.,	Prof. F. Prime, Jr.,
Prof. T. Egleston, E.M.,	Ira Remsen, Ph.D.,
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R. Hitchcock,	Prof. A. P. S. Stuart,
S. Hughes,	D. K. Tuttle, Ph.D.,
H. C. Humphrey,	E. Waller, E.M.,
C. A. Joy, Ph.D.,	E. H Williams, A.B.

Journal de l'Eclairage au Gaz.

No. 24.

Lime from purifiers.—This substance, as has been lately discovered by accident, when applied to the roots of vines, effectually prevents the diseases which often annoy the vine growers.

No. 1, 1874.

Apparatus for decantation and treatment of **ammoniacal waters.**—Used at the works of Vaugirard.—The principal feature in this mode of treatment is in having a series of tanks one above the other. The waters are run into the upper one and the tar allowed to settle somewhat, and the waters still containing tar are run into the next below and again allowed to settle, and so on through the series. The largest part of the tar collects in the two upper tanks.

No. 2.

Carburetted hydrogen **gas of Chatillon** (Haute Savoie).—The soil beneath this place is impregnated with gas from some subterranean source, a bore hole driven to the depth of only one metre yielding a fair supply of gas, which will burn five or six hours. Attempts are being made to utilize it for processes of illumination.

E. W.

Reimann's Farberzeitung.

No. 2.

Cotton dyeing.—**Darkening of anilin** colors with copperas.—The darkening of anilin colors with copperas is not due to a combination of the copperas with the anilin colors, but to the presence of tannin in the sumach used as a mordant for these colors.

Short Notes from the Literature of the Trade.

For **sizing silk goods.** - Ruby uses a solution of the salt of a fatty acid in benzene, alcohol, etc., as well as a

water solution of ammonia soap, which, in the further operations of sizing, is converted into an insoluble compound.

For obtaining **anthracene.**—Dorselt cools the heavy oils left in the retort, and filters. The residue on the filter is extremely rich in anthracene.

No. 3.

In manufacturing **ultramarine,** Scheffler obtained a yellow ultramarine which, in the progress of the operation, changed to red, and finally to blue. Analyses gave results as follows: 1st yellow, 2d red, 3d and 4th blue.

	I.	II.	III.	IV.
Sulphate of magnesia .	28	24	17	19

The washed product was found to contain:—

	I.	II.	III.	IV.
Silicic acid . . .	49	46	49	50
Sodium . . .	9	10	12	12
Alumina . . .	22	23	20	21
S-t	13	14	14	13
S-b	12	12	12	11

S-t is the total sulphur. S-b the sulphur separated by decomposing with hydrochloric acid.

No. 4.

Dyeing goods in the **indigo vat** with "preparation."—G. Leuchs.—This "preparation" is a by-product in the metallurgy of zinc. It consists of—

Metallic zinc . . .	89 to 91 per cent.
Zinc oxide . . .	8 to 10 "
Iron	0·10 "
Lead	0·25 "

Besides carbon, and traces of cadmium and arsenic. It may contain large pieces of zinc, which should be sifted out. It should be kept from contact with moisture, or it rapidly decomposes the water by the oxidation of the zinc. Aqueous solutions of alkaline or lime chlorides, sulphates, carbonates act upon it readily. The solution best used with it is a mixture of some alkaline salt with the addition of some caustic alkali.

Obtaining **anthracene.**—The dias slate from the neighborhood of Würtemberg has been found, on distillation, to yield an oil rich in anthracene.

No. 5.

Dyeing goods in the **indigo vat** with "preparation."—G. Leuchs.—In hot dyeing lime cannot be used, as it renders the wool harsh. Caustic soda is considered by the author to be very good, but ammonia is stated to be still superior. A combination of the two is advantageous.

Dyeing cotton **turkey-red with artificial alizarine.**—A. Müller.—In using artificial alizarine for turkey red many have found the coloring to be uneven. The fault, as discovered by experiments in a large way, was found to be generally attributable to an insufficient concentration of the paste, the presence of sulphuric acid, too rapid development of the color, wrong proportions of tannin and alumina in aluming, and (most important of all) mordanting with too strong a solution of caustic soda.

No. 6.

Dyeing goods in the **indigo vat** with "preparation."—G. Leuchs.—The proportions recommended to every 1000 pounds water in the vat are—

Soda crystals	30 lbs.
Indigo	1 to 2 "
Preparation	12 to 18 "
Caustic ammonia (sp. gr. 0·96) .	15 "
Ammonic carbonate . . .	4½ oz.

To prevent the preparation from settling too rapidly, fat pipe clay may be added. Other formulæ are also given.

E. W.

Annalen der Physik und Chemie, von J. C. Poggendorf.

No 12.

On the **spectrum of the light of exploding gun-cotton.**—O. Lohse.—A similarity between the spectrum of the light of exploding gun-cotton and the spectrum of the northern lights was noticed, but research failed to establish any identity. The brightest lines in the spectrum of exploding gun-cotton are the two sodium lines, which are much broader than with a genuine soda flame, the most refrangible being always the broadest, though the breadth of the lines depends on the vehemence of the explosion. The spectrum contains two characteristic lines in the green, of which the least refrangible is the brightest. Two well-defined bands in the red and orange were also observed, and also a few faint ones in different parts of the spectrum. The wave lengths in different bands are given in detail.

Jubelband.

This number is issued to celebrate the completion of the fiftieth year of Dr. Poggendorf's management of the Annalen. A brief history of Dr. Poggendorf's connection with the publication is given, in which it is mentioned that since 1824 the contributions of papers to the Annalen have numbered 8850, coming from 2167 authors. The names of some of the most frequent contributors are given, with the number of contributions supplied by each. Among these it is recorded that H. Rose contributed 193, Poggendorf 152, Rammelsberg 177, Berzelius 112, Dove 104, G. Rose 100, and among foreigners Brewster 67, and Faraday 76. The jubilee number is more than a double number, containing 685 pages of interesting scientific matter. Among those relating to chemistry are the following:—

On the **constitution of hydrochloric acid** and the hydrochlorates.—J. Thomsen.—The author contends that hydrochloric acid is really a hydrate of the form H_2O,ClH. His researches on which this view is based are summarized as follows: 1. The isomorphism of the hydrous chlorine compounds with other salts when the first contain for every chlorine atom a molecule of water more than the latter.

2. The specific gravity and specific heat of the aqueous acid.

3. The heat phenomena on the absorption of hydrochloric acid by water, as well as on mixing the aqueous acid with water.

At the end of the paper reference is made to the labors of Rammelsberg on the hypophosphites, and a striking analogy is drawn between the formates, hydrochlorates, and hypophosphites. The formulæ of the three acids corresponding to the above salts are written by him thus—

Formic acid	H.CO.OH
Hydrochloric acid . . .	H.ClH.OH
Hypophosphorous acid . .	H.POH.OH

On the preservation and properties of **palladium foil supersaturated with hydrogen** by electrolysis.—R. Böttger.—Palladium, which had been saturated with hydrogen, was found to retain some hydrogen even after long exposure to red heat. By long exposure to the air, however, at ordinary temperatures, palladium will part with the hydrogen which it absorbed.

On the action of **permanganic acid** with various substances, especially ethereal oils and coal gas.—R. Böttger.

On **new sulphur salts**.—R. Schneider.—Eighth paper.

No. 30. K_2S,In_2S_3 Potassium Indium sulphide.

No. 31. $Na_2S,In_2S_3 + 2H_2O$ Sodium Indium sulphide.

The **"struggle for existence"** among molecules; further contributions to chemical statics.—L. Pfaundler.—An ingenious application of the Darwinian theory to the formation of molecules.

Further researches on **fluorescence**.—E. Hagenbach.

On the formation of **minerals accompanying ores**.—Th. Scheerer.

The advances of **mineral chemistry** as shown in Poggendorf's Annalen for the last fifty years.—C. Rammelsberg.

Spectroscope with fluorescing eyepiece.—J. L. Loret.

On the **spectrum of the northern lights**.—A. J. Angström.

Researches on the **volume constitution of some oxides**.—H. Schröder.—*A*, rhombic and rhombohedric oxides of the formula RO: PbO, HgO, BaO, SrO, CaO, CuO, ZnO.

B, regular oxides of the formula RO: NiO, MgO.

C, spinels, especially magnetic iron and cerousceric oxide.

D, quartz.

On the **dissociation** of hydrated salts.—G. Wiedemann.—The mode of conducting the investigation and a series of results obtained with different salts are given.

No. 1.

On **cosmical dust**, which falls upon the surface of the earth with precipitations from the atmosphere.—A E. Nordenskjöld.—Some snow falling in Stockholm was found to contain numerous black particles containing carbon, iron, phosphorus, cobalt, and possibly nickel. The same substance was also found in some snow collected during a storm in the midst of an uninhabited region.

The dust collected on the surface of the polar ice of Spitzbergen (Kryokonit) appeared to be very similar to the above mentioned. Some was also collected on the surface of the inland ice of Greenland, 700 metres above the level of the sea.

No. 2.

Thermochemical researches.—J. Thomsen.—XIII. Continuation of researches on some oxidizing and reducing agents.

No. 3.

On new **sulphur salts**.—R. Schneider (ninth paper).

32. Potassio-nickel sulphide—

$$K_2S,3NiS \text{ or } K_2S,Ni_2S \Big\} Ni_2S_2$$

33. Potassio-cobalt sulphide (?) and cobalt sesquisulphide. The first could not be obtained in such form that it could be examined. The latter was readily obtained as Co_2S_3.

34. Sodio-manganous sulphide and manganous sulphide: $Na_2S,2MnS, Na_2S,3MnS$ and MnS. E. W.

Annales de Chimie et de Physique.

February, 1874.

Researches on the **absorption of ammonia by saline solutions**.—F. M. Ravult.—The apparatus with which the determinations were made is described, and also the result of experiments on the absorption of NH_3 for pure water at different temperatures. Experiments with solutions of sodic and potassic hydrate showed that under the same pressure and temperature such solutions absorb less than pure water, and the difference is proportional to the amount of sodic or potassic hydrate in the solution. With concentrated solutions this law did not hold good, as potassic hydrate even when solid will absorb a little ammonia.

Solutions of sodic and ammonic nitrate absorb almost exactly as much as pure water; calcic nitrate absorbs more than pure water, the difference being proportional to the amount of the salt in the solution. The effect of pressure on the latter phenomenon, and the influence of the nature of the liquid on the heat disengaged by the absorption of the ammonia, were also studied.

On the **solubility of calcic sulphate**, and the state of supersaturation of its solutions.—C. Marignac.—Supersaturation of a solution with calcic sulphate was readily effected, the solution coming very slowly down to the state of saturation. By dissolving calcic carbonate in fine powder in dilute sulphuric acid until the liquid reacted neutral, a solution containing 1 part of calcic sulphate in 114 of water was obtained. In dissolving anhydrous calcic sulphate the rapidity of solution was found to depend on the temperature at which the gypsum had been calcined. If dried at 135° to 140° the solution was immediate, but if it had been calcined at a red heat it took some days to obtain a saturated solution. Native anhydrite acted in this respect like the calcined gypsum. The apparently slight effect which particles of the solid have in causing the separation of more solid calcic sulphate from a supersaturated solution is experienced by the necessarily dilute form of the solution. E. W.

Bulletin de la Société Chimique de Paris.

September 20, 1873.

Memoir on the employment of **hydrosulphite of sodium as a means for the titration of oxygen** and oxygenated compounds, and upon some new facts concerning oxygen.—P. Schutzenberger and Ch. Rislen.—The authors say, the process of determining dissolved oxygen by means of a standardized solution already described in a previous number of the Bulletin (v. xix. p. 152), has led to the discovery of some interesting properties of oxygen which will constitute the main topic of this memoir. These new facts have occasioned a modification of the process, to a certain extent. The process thus perfected has been tested daily for five months, with complete success, and we consider it as having assumed a definite form, and recommend it to chemists as being quite as delicate and exact as any volumetric method. Through the rapidity and delicacy of its determinations, and the relatively small amount of oxygenated liquid which is required, it lends itself to a multitude of physiological questions and others which would be unapproachable if it were necessary to disengage the oxygen by boiling it by means of the mercury pump. It is by means of this method that M. Quinquand has been able to study the phenomena of the respiration of fishes, and MM. Shutzenberger and Quinquand, to institute a series of experiments on the respiration of aquatic plants. The authors give a complete description, with cut, of the apparatus and the method, describe especially the determination of both oxygen dissolved in blood and fixed in hemoglobin; they enumerate the facts above referred to, clearly saying that it may be foreseen, in accordance with these incomplete results, that the hydrosulphite may, with the direct apparatus which is described, serve for the titration of a multitude of substances, metals, coloring matters, etc., and that a general volumetric method may be founded upon its employment.

Note on a process for the determination of **hemoglobin in blood.**—Quinquand.—The author's process depends in principle on the following fact which he has proved, to wit, that the maximum volumes of oxygen, absorbable by one unit of volume of a given blood, are proportional to the amount of hemoglobin contained in this blood. It is sufficient, then—

1. To know, once for all, the weight of hemoglobin which corresponds to 1 c. c. of oxygen when the blood has been agitated in the air;

2. To determine exactly the quantity of oxygen contained in the blood in question after it has been saturated.

For the latter determination the author employs the process of MM. Schutzenberger and Risler.

October 5, 1873.

Reciprocal action of **oxalic acid and the polyatomic alcohols** properly so called.—Application to the preparation of formic acid.—M. Lorin.—The author has studied the action of oxalic acid on ordinary glycol, octylic glycol, erythrite, mannite, dulcite, and quercite, and has obtained results identical with those given by glycerin, and he has drawn the following conclusions:—

1. From the first addition of an equivalent of common oxalic acid, formic acid is almost entirely fixed on the equivalent of the polyatomic alcohol.

2. The physical properties of the alcohol exercise an influence on the stability of the oxalic acid. The temperature of decomposition of the acid, which is variable from one polyatomic alcohol to another, remains constant for each one of them, the relation between the equivalents of acid and alcohol being the same. Mention should be made of the two isomeric alcohols, mannite and dulcite; the latter remaining inactive or nearly so when the reaction with mannite is in full activity. The final product given by dulcite is solid, while that of mannite is liquid, both experiments being made under the same conditions. This circumstance would lead to a preference for dulcite over mannite for the preparation of purer formic acid.

3. Water exercises also a preponderating influence, both that which is due to the generation of formine, and also the water of crystallization of oxalic acid. It contributes to the regularity of etherification of oxalic acid and to the constancy of the limit.

4. The bihydrate of turpentine does not react on oxalic acid; it is simply decomposed in water and the essence.

The author treats, in the next place, of the industrial preparation, and says that he has shown that the preparation of formic acid, up to 56%, is continuous and regular, and that one obtains an acid having a mean strength of 75 and at its maximum of concentration by the action of anhydrous oxalic acid on formic acid already concentrated.

The author says, *en résumé*, that the division of oxalic acid into carbolic acid, water, and formic acid, in presence of certain saccharine substances, has been considered one of the best defined of the phenomena of contact, but that this opinion can no longer be sustained. We are compelled to see in this phonomenon, as far as regards formic acid, an extension of the etherification laws announced by Péan de Saint Gilles and M. Berthelot, a slow and progressive combination, incomplete and tending towards a limit.

The author refers to the analogy between the action of oxalic acid on polyatomic alcohol, and that of sulphuric acid on monatomic alcohols, and describes a strong distinguishing difference between the two phenomena, and closes with the remark that another theoretical consequence of this investigation is the proof, in general, of the existence of formic ethers and polyatomic ethers properly so called.

On the **chlorhydrate of terebene** and on the isomerism of compounds of the formula $C_{10}H_{16}HCl$.—J. Riban.—The author describes the preparation and the properties of the chlorhydrate of terebene, and makes the following remarks concerning the compound to which reference is made in the title among these compounds He says: "One recognizes notably the chlorhydrate of turpentine, the active and inactive chlorhydrates of camphene, the chlorhydric ethers of the natural and the artificial borneal, and the chlorhydrate of terebene."

The author thought that the action of water would throw some light on the question of isomerism, and established from his experiments the following facts:—

1. Chlorhydrate of turpentine is not decomposed by cold water and furnishes only traces of hydrochloric acid at 100°.

The chlorhydrates of camphene are slowly decomposed by cold water and by water of 100°, with regeneration, in the latter case, of the primitive crystallized camphene, which proves, in a most decisive manner, that this carburet cannot be considered as the base of chlorhydrate of turpentine.

3. The chlorhydric ethers of the two borneals undergo a similar decomposition under the same conditions, but with less intensity.

4. Chlorhydrate of terebene decomposes at the ordinary temperature, and most rapidly of all under action of cold water, furnishing with water at 100° only liquid compounds, contrary to observation in the case of the chlorhydric combinations of the camphenes and the borneols.

By treating at 100° all the chlorhydrates with twenty-five times their weight of water, all the other conditions of the experiment being the same in all cases, the author has been able to construct curves which express their decomposition in functions of time and illustrate the isomerism of these substance.

October 20th.

Researches on the **oxygenated compounds of nitrogen**; their stability and reciprocal transformations.—M. Berthelot.

Synthesis of **oxalylurea** (parabanic acid). — E. Grimaux.—The author attained the synthetic preparation of parabanic acid by the reaction of the oxychloride of phosphorus on oxaluric acid.

He thinks that the appellation of parabanic acid should be dropped; it signifies a passing by, and was discovered simply to recall the transformation of oxalylurea into oxaluric acid in the presence of alkalies. The name of oxalylurea, which indicates its constitution and origin, seems to the author more rational.

On the solubility of **succinic acid in water.**—Edme Bourgoin.—All the classic authors state that succinic acid is soluble in five parts cold water. By comparing the solubility of succinic acid with that of its bromurated compounds, the author has found that this assertion is erroneous, that the solubility is about four times less. One hundred parts water dissolve 5·743 parts succinic acid.

Note on the metallurgical treatment of the **bismuth ore at Meymac** (Correze).—A. Carnot, Engineer of Mines.—The ore which, at present, is mainly the hydrocarbonate, is crushed and treated with hydrochloric acid. The bismuth is precipitated with metallic iron and the fine metal is afterward packed in plumbago crucibles, covered with charcoal, and fused.

On the combinations of **thorium.**—P. T. Cleve.—In

addition to descriptions of the result of his determination of the atomic weight, which he considers to be 234.

November 20, 1873.

On **pentachloruretted benzenes.**—A. Ladenburg.—The author gives some details for addition to his former article on the same subject. He considers that the existence of a second pentachloruretted benzene has not been proven with certainty.

On **oxalines**, a new class of ethers of the polyatomic alcohols properly so called. A new characteristic of these alcohols.—M. Lorin.—The very great solubility of oxalic acid in glycerin, the variation of temperature with which the decomposition with alcohol takes place, etc., seem to favor the hypothesis of a combination of the acid with glycerin. The author describes some experiments in confirmation of the existence of oxalines.

The author has verified, for ordinary and octylic glycols, glycerin, erythrite, mannite, dulcite, and quercite, the property of producing oxamide with oxalic acid, under conditions which he explains, and says that the same property ought to be found in pinite. Sugar, glucose, and milk sugar do not exhibit this property, and the monatomic alcohols give, in general, only a cloudiness under the same conditions, unless the precautions be overlooked. Thence the conclusion that the property of thus producing oxamide may serve as a means for recognizing and defining the chemical function of an alcohol whatever its atomicity may be.

On the **power of rotation of the hyposulphates.**—E. Bichat.—The author sustains M. Pape's announcement of the rotatory power of the crystals of hyposulphates of potassa, of lead, of strontia, and lime; also the statement of the same chemist that the crystals of hyposulphate of potassa belong to the regular hexagonal system.

Contrary to the results of M. Pape, however, and in accordance with theory, he has found that the crystals of the hyposulphates of potassa and of lead are hemihedral, and that the hemihedrism is intimately related in order to the rotatory power.

December 5, 1873.

Miscellaneous Notes.

M. Fredel, having determined the facility with which bromochloride of carbon CCl_3Br, produced by the action of bromine on chloroform, loses its bromine in the light, thought that, by removing the bromine as fast as it was set free, the reaction might be carried to the end, and has found, in fact, that *bromochloride of carbon* when *exposed to* the *light* in the *presence* of *zinc powder yields bromide of zinc* and *sesquichloride of carbon* C_2Cl_6. The same author had analyzed a *telluride of gold* and *silver* from some old mines near Kara-Hissar in Asia Minor. The composition was the same as that of Hessite: 24 per cent. tellurium, 37 per cent. silver, 27 per cent. gold, mixed with the sulphides of lead and of zinc.

M. Girard announced that *blue-blacks* can be obtained directly *upon cotton* by replacing the aniline salts by sodic or ammonic salts of the sulphoconjugate acids of diphenylamine. He also exhibited a *liquid ditoluylamine*, boiling at 295° to 300°, and obtained by the action, under pressure of liquid toluidin on the chlorohydrate of the same toluidin.

Action of **aerated water on lead** considered in relation to hygiene and medical jurisprudence.—M. Fordos.—The author thinks that the danger connected with the use of lead pipes for conveying water has been greatly exaggerated. He at least has found in several examinations of ten litres at a time, only traces of lead in the water of the Pharmacy and the Charity Hospital. Much greater danger is to be apprehended from the use of lead for cleaning bottles and utensils destined to contain wine, food, or medicine.

Experts in poison cases should inquire concerning the purity of any liquids taken prior to death for the sake of nourishment or medicine.

The **waters of the Seine** and of the Ourcy **attack lead.**—M. Fordos.—As a result of his experiments the author has found:—

1. That the waters of the Seine and of the Ourcy attack lead only more slowly than distilled water.
2. That the action is more rapid in proportion as the lead is more divided.
3. That the action is greater with lead that has been used before.
4. That the product consists of the carbonate of lead and of lime, and that the waters contain no lead in solution, or only in infinitesimal quantity.

On some minerals of the **bismuth deposit of Meymac.**—M. Ad. Carnot, Engineer of Mines.—A list of the most noteworthy mineral species which the author found in the above-mentioned deposit, and including bismuth, native, sulphuret, oxide, and hydrocarbonate, and antimonial; mispickel, carbonate and sulphate of lead, molybdate of lead, wolfram, tungstate of lime, and hydrated tungstic acid.

December 20th.

M. Friedel has fused silica, precipitated and dried, with phosphorus salt and phosphate of soda, according to the process by Rose, and obtained a crystalline powder made up of very small hexagonal prisms which could not be measured, and which confirmed on analysis the results obtained for tridymite by M. von Rath.

On the **rotatory power of mannite.**—L. Vignon.—A saturated solution of boric acid and mannite produced a deviation of five divisions to the right. A solution in one part water of two grains of borax and mannite to saturation gives a deviation of twenty divisions to the right. Mannite may contain a little sugar, but the author has found that borax does not produce any appreciable increase in the rotatory power of sugar. He concludes that mannite is an active substance; that the boric acid and the borax are not combined with it, and that they only increase by virtue of a peculiar property, the dissymmetry which pre-existed in its molecules.

January 5, 1874.

Note on a **phosphate of cerium containing fluorine.**—M. F. Radominski.—In a future paper the author will give the analytical results from an examination of a mineral which he found at Kararfvet near Fahlun, in Sweden, and which contained phosphoric acid, and the oxides of cerium, lanthanum, and didymium, as well as notable proportions of fluorine and oxide of iron which were not found in the monazites analyzed by MM. Kersten, Hermann, and Damour.

On the transformation of the **essence of turpentine and of terebene into cymene.**—J. Ribon.—A reply to the objection advanced by Mr. Wright, that the cymene claimed to have been found by the author as the result of the above-mentioned transformation really pre-existed in the essence of turpentine. The author discusses the considerations on which Mr. Wright bases his objection, relating experiments which seem only to confirm the conclusions of his preceding memoir, to wit:—

1. That turpentine, under the conditions in which it is placed for transformation into terebene, is partially changed into cymene, with disengagement of sulphurous acid.
2. That terebene when treated with sulphuric acid, warm or cold, is transformed into cymene with formation

of sulphurous acid, and that the disengagement of this gas is correlative with the formation of this carburet by virtue of the following equation:—

$$C_{10}H_{16} + SO_4H_2 = C_{10}H_{14} + SO_2 + 2H_2O.$$

It may be admitted that the transformation of turpentine is of a double nature. In the first phase, the sulphuric acid changes this essence into terebene; in the second phase, the latter is changed into cymene.

The author does not deny the pre-existence of small quantities of cymene in the turpentine; but he shows how the former may be produced through the property possessed by turpentine of ozonizing the air with which it may come in contact, thus rendering its hydrogen liable to be burned by this ozone with formation of cymene. The small proportion, even 3 per cent., of this carburet found by Mr. Wright was probably much too large, for it is said that a part of the cymene considered as pre-existing may have been formed during the treatment of the turpentine with sulphuric acid by virtue of the afore-mentioned property.

New color reactions of the phenate of ammonia, considered in relation to erythrophenic acid.—S. Cotton.—In the month of December, 1872, while seeking to transform phenic acid into anilin by means of ammoniacal salts, the author observed the production of a beautiful blue color. Suspecting an oxidation, he was led to examine the action of chlorine and the hypochlorites on a mixture of phenic acid and ammonia. He obtained certain results which he details, and which led to the following conclusions:—

1. The color derived from the phenate of ammonia affords a strong analogy with that derived from phenate of anilin.

2. The action of chlorine and the hypochlorites upon these two compounds, may furnish a distinguishing characteristic for phenic acid, but not for anilin.

3. Bromine and the hypobromites give very delicate reactions for the distinguishment of phenate of ammonia from phenate of anilin. (The author does not use the terms phenate of ammonia and phenate of anilin in the sense of defined salts.)

The author was engaged in studying the application to dyeing of the product obtained from the action of chlorine or the hypochlorites on a mixture of phenic acid and anilin, when the paper of M. Jacquemin on the same subject was presented to the Academy of Sciences in August.

January 20.

On dextrine.—M. Lucien Bondonneau.—In a paper on dextrine, M. Mulder asserts the existence of three isomers, each corresponding to a different process of manufacture: torrefication of starch, action of diastase, action of dilute acids. He claims that these dextrines possess two properties in common: 1, reduction of copper salts in alkaline solutions; 2, formation of brown coloration with caustic alkalies.

The author claims that the dextrine of M. M. was adulterated with glucose, and that the latter gave the reactions which M. M. considered to be characteristic of the dextrine; that alkaline solutions of copper salts are not detective reagents for dextrine. He describes a process for the preparation of pure dextrine, and which embodies the destruction of glucose by oxide of copper.

Preparation of **anhydrous nitric acid.**—M. Berthelot.—The author describes an easy method of preparing this beautiful substance through the reaction of anhydrous phosphoric acid on monohydrated nitric acid.

On **nitrite of ammonia.**—M. Berthelot.—The author describes the preparation and properties of the above-mentioned salt. The author obtained the salt by double decomposition between concentrated solutions of nitrite of baryta, perfectly pure, and sulphate of ammonia in strictly equivalent proportions. The operation lasts several weeks, and yields scarcely 30 or 40 per cent. of the theoretical returns, by reason of the spontaneous decomposition of the salt.

On **standardized solutions of permanganate of potassa.**—M. Berthelot.—The author considers the employment of a standard solution of pure oxalic acid the only process worthy of great reliance on standardizing permanganate of potassa. The ferrous sulphate and the double sulphates of iron and potassa, as well as of iron and ammonia, are subject to alteration, especially in solution. The employment of double sulphates even in a dry state is not very safe, by reason of their state of hydration, which can never be guaranteed within a demi-centième.

Metallic iron requires a separate weighing each time, and does not give the greatest precision, by reason of the carbon which it contains. In passing from the protoxide to sesquioxide, one part iron requires 0·142 oxygen; one part carbon in passing to carbonic acid requires 3·67 oxygen. One thousandth of carbon is therefore equivalent to twenty-sixth thousandths of iron, or one-fortieth of total weight, a proportion which cannot be overlooked in exact determinations.

On the **variable cohesion of precipitates.**—M. Berthelot.

On **anhydrous acetate of soda.**—M. Berthelot.—M. Reischauer has stated that fused acetate of soda deliquesces in moist air, taking up fourteen equivalents of water, and forms a supersaturated liquid which crystallizes rapidly and yields the hydrated acetate, $C_4H_3NaO_4 + 6HO$; it then loses by spontaneous evaporation the excess of eight equivalents of water. The hydrated acetate, on the contrary, loses all its water in a vacuum at the ordinary temperature, but the anhydrous salt thus obtained comports itself differently from the fused salt according to M. R., for it absorbs from the atmosphere the sixth equivalent of water which it has lost without liquefaction, evincing a case of isomerism. M. Berthelot has submitted the question to thermic tests, and concludes that the anhydrous alkaline acetates are identical whatever may have been the preliminary condition of the removal of the water; that the solutions of the anhydrous acetate are identical with those of the hydrated salt; and that no isomerism exists, either between the anhydrous salts or the solutions of the different acetates.

The author gives a different explanation of the interesting experiments of M. Reischauer. T. M. B.

Les Comptes Rendus de l'Académie des Sciences.

Vol. 78, No. 7.

Action of **soft water upon metallic lead.** Research by the electrolytic method.—Mayerçon and Bergeret.—The results arrived at are: 1. That sulphydric acid is not so delicate a reagent for lead as the deposition of the metal upon a platinum wire, converting it into chloride by a moment's exposure to chlorine, and then touching a paper moistened with iodide of potassium. 2. That soft river water, more or less calcareous, dissolves metallic lead; and 3. That lead in very small quantity *seems* completely inoffensive to the public health.

Upon the **preservation of wood** by sulphate of copper.—M. Bouchere.—The author reviews some previous opinions upon the preservation of wood, and gives the preference to sulphate of copper over tannate of iron.

A new method of **determining vapor density.**—M. Croullebois.—The author employs a glass globe of 1½ litres capacity, to which is joined a tube, 1½ metres long, by ·02 metre in diameter, divided into millimetres. It is filled with pure dry mercury, inverted in a mercury trough, the level read off and compared with the barometer, a little of the substance—the method being adapted especially for volatile bodies—weighed in a glass bulb introduced by breaking the point of the bulb inside the tube, and reading the new level of the mercury. Hence data sufficient for calculating the vapor density are obtained.

No. 8.

Determination of **vapor densities.**—St. Claire Deville.—A caustic criticism of M. Croullebois' method of determining vapor densities. M. Deville touches especially upon the difficulty of introducing into so small a tube as the neck of M. Croullebois' globe a sufficient quantity of the volatile material, without having some stick to the glass, however volatile it may be—and escape vaporization. He criticizes M. Croullebois for not giving results of experiments.

Distribution and determination of **thallium.**—T. L. Phipson.—The author states that in 1864 he found a considerable amount of thallium in metallic cadmium, and that he has since found it present in a great number of commercial substances.

He believes that thallium is as widely diffused as lead. Besides cadmium, he has found it in Spanish and Norwegian cupriferous pyrites, and many other minerals.

Presence of **metallic silver in Galena.**—T. L Phipson.—The author has examined a sample of Galena from the Phœnix mines in Cornwall, which was interpenetrated with threads of metallic silver.

No. 10.

Note upon hydrogenized palladium.—Troost and Hautefeuille.—The authors examine the questions: 1. Does hydrogen form a true combination with palladium, or is it simply dissolved in that metal? 2. If a combination takes place, what is the formula of the product?

The authors study these problems by determining the tension of the hydrogen gas disengaged from hydrogenized palladium at different temperatures. The table they give shows: 1. That palladium forms with hydrogen a definite compound of the formula Pd_2H (H=1, Pd =106·5). 2. That this combination once formed can dissolve hydrogen gas as platinum does, and in an amount varying with its physical state. This property of Pd_2H explains the difference among the numerical results obtained by Graham. The authors state their ability to show that potassium and sodium form with hydrogen the compounds K_2H, Na_2H (K=39, Na=23).

No. 11.

Upon the heat of **combustion of different varieties of red phosphorus.**—Troost and Hautefeuille.—The aspect of red phosphorus depends upon the temperature at which it is prepared. Prepared at 265° it is of a magnificent red with a vitreous fracture. At 440° it is orange. Above 500°, it is more compact, and of a bright violet-gray.

Red phosphorus prepared at 265°, and freed from ordinary phosphorus has a density at zero of 2.148. Its heat of combustion is 320 units of caloric per gramme greater than that of crystallized red phosphorus.

Ordinary red phosphorus gives 568 units of caloric more than red crystallized phosphorus.

The properties of red phosphorus, it is shown, vary with the temperature at which it is produced, and it does not preserve the characters we are accustomed to find in definite species except when it is crystalline.

Chemical nature of **sulphide of iron** (troïlite), contained **in meteoric iron.**—Stan. Meunier.—The author, who had previously combated the opinion of Lawrence Smith, that the mineral in question is FS, Meunier insisting that it is F_7S_8, now finds confirmation of his theory in the fact that protosulphide of iron produces in a solution of sulphate of the binoxide of copper an instantaneous metallic deposit of copper, while troïlite has no action at all.

Phosphate of cerium containing fluorine.—F. Radominski.—The author gives the analysis of a mineral considered, at Kararfvet, near Fahlun, where he collected it, as monazite. It had a clear yellowish-brown color, vitreous fracture, and was lucid, sp. gr. 4·93. It was found in felspar, associated with gadolenite, emerald, etc.

The analysis gave—

Oxide of cerium, " lanthanum, " didymium	67·40
Lime	1·24
Magnesia	trace
Oxide of iron	·32
Phosphoric acid	27·38
Fluorine	4·35
	100·69

No. 13.

Action of **ammonia upon acetone.**—Œchsner and Pabst.—The authors have studied the reaction of very pure acetone and ammonia upon each other when heated in sealed tubes, M. Vincent having attributed the presence of aldehyde and methylamine in crude pyroligneous acid to the mutual interaction of the first-named bodies, and have found:—

1st. That no trace of methylamine or of aldehyde is formed by the reaction of ammonia upon acetone.

2d. That the product of the reaction of these two bodies is nothing but the acetonine of Stædeler.

Upon Egyptian blue.—Fontenay.—The author, after remarking that with only three elements, sand, soda, and lime (with traces of copper), the ancients made—

1st. Glass, which the copper colored blue, green, and red;

2d. A beautiful and brilliant glaze;

3d. A painter's color;

goes on to give the results of his synthetical experiments in making the Egyptian blue. By mixing—

White sand	70 parts
Black oxide of copper	15 "
Chalk	25 "
Sodic carbonate	6 "

he obtained, after sufficient exposure to the heat of a fire, a blue resembling the azure of the ancients. The fire heat should be gradual and not exceed 1000°.

No. 14.

Experimental researches upon **bihydrated sulphuric acid.**—Pierre and Puchot.—The authors state that they have preserved for forty-eight hours in a bath whose temperature remained at 8°–9°, the crystallized acid $SO_3.2HO$, which at the end of the time had just begun to melt, and further, that 7°·5 is the point at which the solid acid melts and the liquid solidifies.

The form of the crystals is oblique rhomboidal. By mixing 800 grms. of ice with 200, 300, and 375 grms. of the crystallized acid, the respective temperatures of —25°, —26°·25, —26° were obtained, while 225 grms. of ice and 100 grms. of the acid gave hardly —17°·5. The authors tried without success to concentrate by

cold sulphuric acid containing more than 2 equivalents of water to one of acid.

Density of hydrogen when combined with metals.—Troost and Hautefeuille.—The authors show, from their own and Graham's researches, that the density of hydrogen in combination with metals is ·62, thus—

$Na_2H = 47 = \frac{47}{·959} = 49·01$ av. vol. Na_2H.

$Na_2 = 46 = \frac{46}{·97} = 47·42$

the density of H = ·629 = 1·59; hence is deduced

$Pd_2H = 214 = \frac{214}{11·06} = 19·3$

$Pd_2 = 213 = \frac{213}{12} \quad 17·7$

1·6; hence is deduced the density of H = ·62.

Brominated derivatives of pyruvic acid.—E. Grimaux.—The author has studied the action of bromine upon pyruvic acid, and has obtained dibromopyruvic acid $C_3H_2Br_2O_3$, on tribromopyruvic acid $C_2HBr_3O_3$.

The first acid may also be obtained by acting upon dibromolactic acid with chlorine.

Tribromopyruvic acid is extremely unstable, and gives with urea product not yet examined.

No. 16.

The **phyllaxera and the American vines at** Raqueman.—Planchon.—This article gives details of the experiments conducted in the planting of American vines—Clinton, Ives' Seedling, and others—by M. Borty, at Raqueman, in one of the divisions of France most infested with the phyllaxera. The success of the experiment has been complete, the vines after a trial of ten years flourishing where the French varieties have failed.

Upon the part played by salts in the action of potable **waters upon lead.**—Fordos.—After showing that the presence of bicarbonate of soda and carbonate of magnesia in waters insures the almost absolute absence of lead although the waters be drawn through leaden tubes, the author goes on to discuss the action of sulphate of soda which forms a not wholly insoluble sulphate of lead, and further, oxide of lead forms with soda a soluble compound. Chloride of sodium, nitrate of potassa, and nitrate of ammonia behave like sulphate of soda, that is, they cause some lead to go into solution.

The author sums up by saying that it is prudent to filter the water that comes through lead pipes, and to reject that which has been in contact with lead for a long time.

On the **tetraiodide of carbon.**—Gustavson.—The author prepares tetraiodide of carbon by the mutual reaction of tetrachloride of carbon and iodide of aluminum, the two bodies being dissolved in sulphide of carbon.

The product is dried in a current of carbonic acid, washed with a solution of bisulphite of soda and then with water. The crystals of tetraiodide of carbon are deep red, their powder bright red. Heated in the air it decomposes. Chlorine and bromine convert it into chlorine and bromine compounds of carbon. Heated with water it gives iodoform.

New researches upon **black phosphorus.**—Blondlot.—The author combats the recent statement of Ritter that black phosphorus owes its color to a small percentage of arsenic, as he has not been able to obtain such a phosphorus by treating normal phosphorus with arsenic. He defines a black phosphorus as one that when it is in fusion does not differ from normal phosphorus, but becomes black upon cooling.

Action of **pure hydrogen upon nitrate of silver.**—Pellet.—The author, in undertaking to reconcile the contradictions of Houzeau, Regnault, and Russell, has come to the following conclusions:—

1. A neutral, or very slightly acid solution of nitrate of silver is not reduced in the cold by hydrogen.

2. An alkaline nitrate undergoes in the cold a reduction proportioned to its alkalinity, and elevation of temperature accelerates the reducing action.

3. Hydrogen has no action upon an acid solution of nitrate of silver, warm or cold.

4. Nitrate of silver cannot exist in the presence of nitric acid, especially if warmed.

Action of **bromine upon bromosuccinic acid.**—Bourgoin. The author shows that if 7 grms. of bibromosuccinic acid, 3 c. c. of bromine, and 30 c. c. of water be heated in a sealed tube 20 hours at 102°–103°, the product is mainly tribromosuccinic acid, with some bibromomaleic acid into which second acid, the first is converted by heating its aqueous solution. There is also formed hydrate of tetrabromide of ethylene.

Determination of alcohol in water in wines and sugar solutions.—Salleron.—The author shows that in mixtures of water and alcohol the weight of the drops diminishes as the alcoholic richness increases, and that for each degree the differences are variable, and that these differences are very considerable in liquids which contain much water and little alcohol, and that a table of the weight of drops which he has constructed makes it possible to determine alcohol in weak liquors with much precision.

General method for the **transformation of alcohols into nitric ethers.**—Champion.—The author gives the details of his method, which is founded upon the reciprocal action of nitrosulphuric acid and the combinations of alcohols with sulphuric acid, and enables him to work at ordinary temperatures upon considerable quantities of material.

On **phenylallyl.**—Radiszewski.—The author obtains this body by acting upon phenylpropyle at 150°–160° with the vapor of bromine, and distilling the product. It is a limpid, mobile liquid, of a piquant odor. It boils at 164°–165°, at 728 mm. The sp. gr. = 5·924 at 16° C., the vapor density = 4·01. It combines easily with bromine. They note that Fittig and Krügener have obtained, by the action of an amalgam of sodium upon cinnamic alcohol, a phenyllyl which boils at 165°–170°, and state that they are not yet ready to explain the isomerism which appears to exist.

Upon **pyrogallol in presence of salts of iron.**—Jacquemin.—In the presence of organic ferric salts pyrogallol does not behave as with ferric salts with mineral acids; it produces a blue soluble in water and persistent for several hours. The author adds that the action of ammonia upon a pyrogalloferric chloride is so delicate that with the aid of 1 gramme of chloride of iron 100 hectolitres of water may be colored, and that every substance which changes this solution to blue, violet, or reddish-purple, can be classed as an alkali or alkaloid. This gives a means of distinguishing between an alkaloid and a glucoside.

On the **coloring matter of wine.**—Duclaux.—According to the author the coloring matter of wine, before it has been exposed to the action of the air, is a transparent substance having the color and consistency of

gooseberry jelly. It is soluble in water and alcohol, and gives to them a gray tint which a trace of acid makes bright red. Exposed to the air it absorbs oxygen, deepens in color, and becomes less soluble, and finally insoluble in water, but soluble in alcohol, and in this state is less soluble in acidulated liquids than in neutral, the reverse of what has hitherto been believed.

To recognize the fraudulent addition of *maure* to wines the author utilizes the action of oxygen, by which this coloring matter becomes more and more soluble in water, the reverse of the true coloring matter of wines.

To detect *cochineal*, the spectroscope is used. To detect the addition of *phytolacca* the author employs nascent hydrogen, under whose influence the phytolacca color disappears suddenly, but the true wine color very slowly.

If $\frac{1}{5}$ of the coloring matter be phytolacca the wine decolorizes ten times as fast as if it were pure.

No. 18.

Action of **distilled water upon lead.**—Isadore Pierre.—The author let steam pass for eight hours through a serpentine coil of lead pipe, used in a steam-heating apparatus—for the purpose of cleaning it—and then allowed the steam to circulate for three days, only a part of the steam escaping. The condensed water had a milky, opaline aspect, and deposited ·0747 gramme of hydrocarbonate of lead per litre.

The limpid filtered water treated by sulphydric acid gave only doubtful signs of the presence of lead, although it was clouded by carbonate of ammonia. A litre of water treated with carbonate of ammonia, filtered and evaporated, gave ·00375 gramme of a residue containing lead. The water, therefore, contained at least ·07845 gramme of hydrocarbonate of lead per litre.

Process of **determining phosphoric acid.**—F. Jean.—The phosphatic material is dissolved in nitric acid, the filtered solution is mixed with ammonia in excess, and the precipitate formed is dissolved in citric acid, and the resulting solution boiled with acetate of uranium. The washed and ignited precipitate contains 20·04 per cent. of phosphoric acid. The filtrate gives no signs of the presence of phosphoric acid. The author describes this as the only method which permits the *direct* determination of phosphoric acid in the presence of bases.

Influence of the presence of nitrogen in textile fibres upon the **fixation of aniline colors.**—Jacquemin.—The author shows the justice of the ordinary expression to "animalize" cotton in order to make it capable of being dyed with aniline colors, by experiments upon gun-cotton, which can be dyed with aniline colors without the intervention of a mordant. The dyed cotton retains its combustibility.

No. 19.

Upon **albumenoid matters.**—A. Commaille.—The author disputes the dictum of certain chemists that the albumenoids are only proteine associated with bases or salts. He has shown that the albumenoids do not all combine with the same weight of platinum, those of animal origin uniting with more metal than those from the vegetable world.

The author and Millon regard the albumenoids as quaternary bodies which can be represented as amides of leucine (capronamic acid), and of tyrosine, which is, according to Commaille, the amide of acetobenzoic acid $C_{18}H_{11}O_6N$.

The author affirms that the albumen of milk and of dropsical fluids is the same as the albumen of the serum of the blood (Pt=8·50 per 100), that in the blood the fibrine is only albumen dissolved in the serum. Vitelline resembles the hardened white of egg (Pt=8 per 100), while the caseine of milk is connected with certain vegetable principles known as vegetable caseines (Pt. = 6·50 per 100).

Researches upon **coniferine.** Artificial production of the aromatic principle of **vanilla.**—Tiemann and Haarmann.—The cambium of the coniferæ contains a glucoside, magnificently crystallized, coniferine, discovered by Hartig, and studied by Kubel, represented by the formula $C_{24}H_{32}O_{12} + 3$ Aq. The authors regard its molecule as $C_{16}H_{22}O_8 + 2$ Aq. Submitted to the action of emulsine, coniferine splits up into glucose and a body crystallizing in beautiful prisms which melt at 73°, easily soluble in ether, less in alcohol, almost insoluble in water. Its composition is $C_{10}H_{12}O_3$, formed by the reaction—

$$C_{16}H_{22}O_8 + H_2O = C_6H_{12}O_6 + C_{10}H_{12}O_3.$$

When oxidized by bichromate of potassa this body gives a crystalline body identical with the odoriferous principle of vanilla, vanilline, and having the composition $C_8H_8O_3$.

No. 20.

Upon the combinations of **arsenic and molybdic acids.**—Debray.—Arsenic acid forms with molybdic acid combinations as complex as the phosphomolybdates, and as well defined as they. Arsenic acid gives in a nitric acid solution of molybdate of ammonia a yellow precipitate, which is the ammoniacal salt of an acid corresponding to the phosphoric acid compound, and is $3NH_4O, AsO_5, 20MoO_3$. This is a salt of the *yellow* arseniomolybdic acid, there being another, a white acid, having the formula $AsO_5, 6Mo_3 + 16HO$. The author has studied the potash, soda, and ammonia salts of the yellow and white acids.

Upon the use of grains of iron in place of shot for **rinsing bottles.**—Fordos.—After commenting upon the danger resulting from the use of lead shot in cleaning wine-bottles, the author advocates the use of short pieces of iron wire. The iron oxidizes a little, but the oxide formed does not attach itself to the sides of the bottle, as does the lead oxide.

Soluble starch.—Muscalus.—After remarking that chemists are not agreed what soluble starch is, the author refers to his having obtained what he calls *globulized dextrine*, insoluble in cold water, by dissolving starch in acidulated boiling water and evaporating, after saturation of the acid and filtration, to the consistency of syrup. An abundant deposit is obtained of granules insoluble in cold water, which may be washed and freed from dextrine and glucose.

This is soluble starch, entirely pure. The granules are starch grains *privés de leur organisation.*

Dried in the air it resembles starch. Freshly washed it is insoluble in cold water, and does not reduce salts of copper, but if left some time in contact with water it dissolves sensibly and forms a little sugar. Its rotatory power is four times that of dehydrated glucose. A weak solution gives with iodine a pure red color, and a concentrated solution a violet. Diastase breaks up this soluble starch in the same way as the natural, but more readily. The author has not been able to obtain cellulose pure enough to compare it with starch sugar, but thinks it certain that the difference between their rotatory powers is not great.

Note upon the **decomposition of the tungstate and molybdate of soda by sal ammoniac.**—F. Jean.—If a solution of tungstate of soda be boiled with sal ammoniac, there is obtained, with evolution of ammonia, a crystalline precipitate, insoluble in cold, soluble in boiling water, giving with nitric acid tungstic acid of a pure yellow, and when calcined leaving tungstic acid mixed with blue oxide.

Its analysis gave—

Tungstic acid	89·856
Ammonia	8·258
Water (combined)	1·886

a composition almost identical with the octagonal tungstate, and paratungstate of ammonia, analyzed by Marignac.

The molybdic acid salt prepared in the same way gave—

Molybdic acid	87·50
Ammonia	7·85
Water (combined)	4·65

corresponding to the formula $(NH_4O)_2$, $(MbO_3)_5HO$.

If alcohol be added to the liquid separated from the acid molybdate, a salt is obtained having the composition—

Molybdic acid	78·70
Ammonia	11·10
Water (combined)	10·20

On the **identity of bromoxalform and pentabrominated acetone.**—E. Grimaux.—The author details experiments leading to the following results:—

1. That acetate of methyl and methylic alcohol are not attacked in the cold by bromine.

2. That at 150°–170° acetate of methyl is transformed into bromide of methyl and bromacetic acids.

3. That the body formed by the action of bromine upon the alkaline citrates is pentabrominated acetone.

4. That the chlorized bodies obtained by Plantamour, in the action of chlorine upon citric acid and the citrates, are chlorized derivatives of acetone, as Stadeler has shown, and not derivatives of methylacetic ether, as Cloëz has asserted.

Studies upon the **transformation of iron into steel.**—Bossingault.—A long paper from which we extract the following analytical results:—

Weight of bar 1 after cementation	4994·20 grms.
" " 1 before "	4949·54 "
Increase,	44·66
Weight of bar 2 after cementation	5199·60 grms.
" " 2 before "	5124·00 "
Increase,	75·60

	Before cementation.	After cementation. No. 1.	After cementation. No. 2.
Iron	99·100	98·200	97·650
Combined carbon	0·118	0·995	1·512
Silicon	0·105	0·107	0·120
Sulphur	0·012	0·006	0·005
Phosphorus	0·100	0·125	0·130
Manganese	0·222	0·220	0·218
Undetermined matters	0·343	0·347	0·365
	100·000	100·000	100·000

In another experiment Swedish iron, before and after cementation, gave the following figures:—

	Before.	After.
Iron	99·450	98·170
Carbon	0 300	1·580
Silicon	0·016	0·030
Sulphur	0·015	0·005
Phosphorus	0·057	0·065
Manganese	0·090	0·070
Undetermined substances	0·072	0·080
	100·000	100·000

A spiral of perfectly pure iron wire cemented four hours in wood charcoal gave the following result:—

After cementation	1·7111 grms.
Before "	1·6878 "
Increase,	·0233

In the cemented wire were determined—

Combined carbon	2·23
Graphite	0·08
Total carbon,	2·31

The author has further shown that cast steel of high grades contains no sulphur, or traces at most $= \frac{1}{10000}$ of one per cent.

Rivotite, a new species of mineral from the province of Serida.—X. Ducloux.—This mineral, found in small, irregular masses scattered through a yellowish-white calcareous rock, gave the following results of analysis, viz:—

Oxide of copper	39·50
Carbonic acid	21·00
Oxide of silver	1·18
Antimonic acid	42·00
Lime	traces
	100·

Its specific gravity 3·55—3·62

Its composition $Sb_2O_5,4\left\{\begin{matrix}Cu\\Ag\end{matrix}\right\}OCO_2$.

Upon the action of **sulphuretted urea and bisulphide of carbon upon argentic urea.**—Ponomareff.—The author shows that the filtrate from the sulphide of silver thrown down by a mixture of argentic urea and sulphuretted urea, when evaporated gives a crop of crystals possessing all the properties of ordinary urea. The same result was obtained by operating upon argentic urea diffused in water, with sulphide of carbon.

No. 23.

Presentation of an **ingot of 250 kilogrammes of platiniridium** cast at the Conservatoire *des Arts et Metiers*, May 13, 1874.—General Morin.—This paper is an account of the casting of this enormous ingot, 1·14 m. long, ·178 wide, and ·08 thick, which is destined to form the new metrical standards. The platinum 225 kilo. was obtained from Matthey, of London, and its purity assured by Deville, while the iridium was obtained from the director of the St. Petersburg mines and from the Russian government.

Experimental castings of 5–10 kilos. were successfully made, and finally three ingots of about 83 kilos each were melted.

Analysis showing 10·37 of iridium instead of 10 per cent. 5 kilos. of pure platinum was added in the final melting. The final fusion required less than seventy minutes, seven compound blowpipes being used, and 31 cub. m. of oxygen and 24 cub. m. of street gas. For fusing, therefore, 100 kilos. of a mixture of iridio-platinum, containing 10 per cent. iridium, are required 12·27 cub. m. of oxygen and 9·53 cub. m. of street gas. The ingot was found to be practically perfect and uniform.

Researches upon the **simultaneous diffusion of certain salts.**—Marignac.—The author is thus occupied endeavoring to determine *the relative coefficiency of simultaneous diffusibility*, that is to say, the relation to each other of the weights of those salts which are simultaneously diffused when mixed in equal weights, but has not yet established any general law.

New process for **engraving on copper.**—Bouquet de la Grye.—This consists—

1st. In covering the copper plate with a layer of adherent silver, on which a colored varnish is spread.

2d. In sketching upon this the design, with a dry point.

3d. In biting in the design with perchloride of iron.

Upon the **falsification of beeswax with Japan wax.**—Mène.—Beeswax in France is 3f. 75c. to 4f. the kilo., while Japan wax is 1f. 75c. to 2f. The author has studied various artificial mixtures of the two, and sums up by saying that the specific gravity of the mixture (gradually increasing as the percentage of Japan wax increases) is the only trustworthy indication of fraud, the melting point being absolutely no guide.

J. M. M.

Archiv der Pharmacie.

September, 1873.

Chemical examination of the **slates** of Thuringen near Graefenthal.—Dr. H. Maeder.—A series of twenty-two analyses of slates.

On the formation of **acetic acid.**—L. A. Buchner.—Doebereiner's experiment in 1831, in which spirit of wine was converted into acetic acid by spongy platinum or platinum black, is accepted as proof, that the formation of $C_2H_4O_2$ is simply a process of oxidation, and does not require the agency of any organism. The oxidation is effected by the peculiar property of finely divided platinum to condense oxygen gas and impart it to alcohol.

Beech tree shavings, stalks of grapes, and pieces of charcoal, used by Schuetzenbach in 1823, in his quick method of preparing vinegar, acted in the same way but less energetically.

These facts show that Pasteur's theory of the conversion of alcohol from different sources into $C_2H_4O_2$ by means of a vegetable organism (mycoderma aceti) is not correct; and this view is strengthened by the fact, that Liebig examined with the microscope a shaving from the bottom of a vessel, that had been used uninterruptedly twenty-five years in the manufacture of vinegar, without being able to detect a trace of such organism.

Decomposition of the **crystals of the sulphuric acid chamber.**—Dr. Carl Jehn.—These crystals, in the presence of water, are said to be decomposed into sulphuric acid and nitrous acid, and not into sulphuric acid and nitric oxide, as Hager has stated.

$$SO_2\left\{\begin{matrix}NO_2\\HO\end{matrix}\right. + H_2O = H_2SO_4 + HNO_2.$$

Fatty matter contained in ergot.—Oscar Ficinus.—Some 30 per cent. of fatty matter has been found in ergot, rendering the substance difficult to pulverize, and easy to decompose. It is a thick oil, becoming solid at a low temperature. When fresh it has a smell somewhat like that of cocoa butter, and easily becomes rancid.

On the preparation of **valeric acid.**—Oscar Ficinus.—A method is suggested similar to that in use for the quick preparation of $C_2H_4O_2$, only fusel oil is allowed to drip over shavings of valerian roots, instead of beech tree shavings at a temperature from 30° to 40° C. The method, however, requires much time, and is accompanied with considerable waste of material.

Distribution of **alkaloids in Peruvian bark.**—P. Carles.—The peculiar fracture of different kinds of Peruvian bark has been thought by some a good indication of the quantity of alkaloids contained in them. It has been said also that quinine exists most abundantly in or near the bast. Experiment, however, teaches exactly the contrary. The external part of the bark of many species is found to contain far more quinine than the interior portion. Cinchonine occurs sometimes more abundantly in the outer layer, and sometimes in the bast.

Indian resins and gums.—P. L. Simmonds.—A statement of the sources, quantity, and cost of several kinds of foreign gums and resins.

Strophanthin, a new African arrow poison.—T. R. Fraser.—Recently a new poisonous alkaloid has been discovered in the seeds of a plant growing in many parts of Africa. This plant climbs the highest trees, and resembles in its growth the grape-vine. Its stem is several inches thick, its flowers are pale yellow, and its fruit ripens in June. The natives gather it, and remove the exterior, rough part of the capsule before it becomes dry, and preserve the interior leathery part and the seeds. Dr. Livingstone mentions the poison obtained from it, and says arrows poisoned with it are used to kill wild animals, and not men. Half a grain of the extract from the seeds, dissolved in a few drops of water, and injected beneath the skin of a frog, produces death in two hours.

The production of **cochineal** on the Canary Islands.—J. Mueller.—In 1523 the cochineal was introduced into Europe from Mexico, its native habitation, where it feeds on the cactus. In 1825 its growth was first attempted in the Canary Islands. Here its production has gradually increased, particularly since the use of guano in 1852 in connection with irrigation, until the annual quantity far exceeds that of Mexico itself, and amounts to some 4,000,000 pounds. During the first part of this century, the price of cochineal in London (England), was 12 to 13 shillings a pound. The increased production, and the introduction of aniline and other coloring matters, have reduced its price to from 6*d.* to 2*s.* 3*d.* a pound.

October.

Chemical **examination of slates** in the vicinity of Graefenthal.—Dr. H. Maeder.—A further discussion of the analysis of the Graefenthal slates. The practical conclusion is that durable slates, when treated with concentrated HCl, will not lose more than 30 per cent. to 35 per cent. of their weight. When a slate loses 50 per cent. of its weight by the action of strong HCl, it is not suited to withstand atmospheric influences, and is consequently to be rejected for building purposes.

Quantity of **alcohol in Marsala wine.**—G. C. Willstein.—The red Marsala wine, obtained directly from the producer, was found to contain 17·91 per cent., and the white 17·60 per cent. of absolute alcohol, instead of 25 per cent. to 26 per cent., as stated in Brande's *Handbuch der Chemie.* Alcohol is not unfrequently added to southern wines, and it is possible the larger per cent. stated may have originated in this way.

Barium manganate.—Dr. E. Fleischer.—This substance has been prepared as a coloring material under the name of Casseler or Rosenstiehl's green. The finest green is obtained by igniting barium manganate prepared either by adding $BaCl_2$ to K_2MnO_4, or by heating potassium permanganate with caustic baryta. A less beautiful green is produced by igniting a mixture of caustic baryta, potassium chlorate, and black oxide of manganese (Rosenstiehl's method). The color frequently has a shade of blue, according to the different conditions to which the materials are subjected. Barium manganate, or permanganate, heated to redness with 20 per cent. of barium hydrate gives a blue green.

Preparation of **chromic acid.**—O. Ficinus.—Five parts of English H_2SO_4 added to five parts of a cold saturated solution of potassium dichromate, and the mixture concentrated on a water bath, will give as many and as fine needles of chromic acid, as does the process of Warrington. After dripping, the crystals are pressed between plates of gypsum.

Barium chromate treated with H_2SO_4 failed to give

needle-shaped crystals. By evaporating the liquid decanted from the $BaSO_4$, a black mass was obtained, which, when pulverized, gave a red powder. If the evaporation goes on slowly a blackish crystalline crust is obtained. It is hence inferred, that the needle form of chromic acid crystals is owing to the presence of H_2SO_4. A similar black crust is obtained by removing the barium with HNO_3 according to the process of Duvillier.

Formation of **mold in aqueous solution of organic acids.**—J. C. Blass.—In very weak solutions of citric acid carefully excluded from the air, flocks of fungi appear in a few days floating in the liquid, but do not form a coating at the surface. In solutions containing more citric acid, and therefore specifically heavier, the fungi collect at the surface, forming a kind of leathery coating and bearing spores. In solutions containing more than 20 per cent of acid, less fungi were formed than in weaker solutions. All solutions of citric acid of whatever strength were found to contain citric acid after months of successive formations of mold.

Oxalic acid treated in a similar way gave fungi apparently of the same kind as those formed in citric acid solutions; but the oxalic acid, however, was destroyed by the fungi, and no increase of fungi was apparent after the disappearance of the acid.

A solution of succinic acid behaved in general in the same way. The acid, however, after some ten weeks was somewhat reduced in quantity.

The fungi also in a solution of tartaric acid could not be distinguished from those in the other solutions. In all cases where the solutions were boiled and then carefully excluded from the air, no mold was formed, from which the author infers that the spores of fungi are destroyed by the boiling temperature.

On the **composition of cascarillin.**—C. Mylius and E. Mylius.—Cascarillin is a bitter substance found in cascarilla. It has been mistaken for ricinin by Tusow, with which it has no similarity except in taste. Ricinin is an alkaloid containing nitrogen, while cascarillin is destitute of nitrogen and is indifferent to acids and alkalies. Its empirical formula is $C_{12}H_{18}O_4$.

Chemical examination of **Lukao or Chinese gum.**—Clouz and Guignet.—Lukao is a lac having some 26% of mineral matters, and 10% of water. It contains a blue coloring matter, which is best obtained in the following way. One part of Lukao is treated with one part ammonium carbonate dissolved in 40 parts of water. In four days the solution becomes of a deep blue-green color. It is then filtered, and the filtrate evaporated on a water bath to expel the ammonium carbonate, when a compound of ammonia and a blue coloring matter, called lukain, is obtained. This lukain is soluble in water, and has the formula $C_{56}H_{33}O_{33}$. When acted on by H_2SO_4, it is broken up into glucose, with other soluble products, and a brownish-red substance insoluble in dilute acids. This brown substance bears the name of lukaetin. Lukain then appears to be a glucoside; and lukaetin seems to sustain a similar relation to lukain, that gallic acid sustains to tannin, and that rhamnetin does to rhamnin.

Food of the North American Indians.—J. R. Dodge.—A sketch of the different roots, tubers, barks, berries, and nuts used as food by the various Indian tribes in America. Also their methods of preparing them for eating. A. P. S. S.

Journal de Pharmacie et de Chimie.

December, 1873.

Mode of **production of methylamine** in the manufacture of pyroligneous products.—M. Vincent.—Experiments show that the methylamine does not at first form, but ammonia does, which, in contact more or less prolonged with the volatile products of distillation, gives rise to the formation of mono-, di-, or tri-methylamine. The reactions are given as—

$$C_6H_6O_2 + NH_3 = C_4H_4O_2 + NH_2(C_2H_3).$$
$$C_6H_6O_2 + NH_2(C_2H_3) = C_4H_4O_2 + NH(C_2H_3)_2.$$
$$C_6H_6O_2 + NH(C_2H_3)_2 = C_4H_4O_2 + N(C_2H_3)_2.$$

On the influence which certain gases and some substances exert on the **preservation of eggs.**—F. C. Calvert.—Dry oxygen has no action. Moist oxygen causes a white fungoid growth on the exterior, but does not affect the interior unless the shell is pierced at some point. Nitrogen, whether dry or moist, preserves eggs perfectly for three months.

Hydrogen acts in the same manner.

Carbonic acid gas also preserves them, not the slightest trace of mould appearing on the exterior, as was the case in nitrogen and hydrogen.

Illuminating gas acts in the same manner as carbonic acid. Chlorine water preserved them perfectly, but on taking them out and replacing them again in the solution filaments of *pencillium* made their appearance. Placed in hypochlorite of lime eggs became covered with *pencillium* in ten days. In about ten days more *pencillium* appeared in the yolk.

Lime-water and sulphite of lime gave similar results.

Carbolic acid preserved the interior, but after a considerable lapse of time *pencillium* was detected on the outside of the shell.

Remarks on the **ethereal tincture of iodoform.**—Odin and Leymarie.—Red glass bottles are recommended for preserving this article. The proportions given are 1 grm. crystallized iodoform to 4 grms. ether of 60° B.

Action of water on lead; lead pipes used in the distribution of water in Paris.—MM. Dumas, Belgrand, and Le Blanc.—Water which does not stand over nine or ten hours in a lead pipe in Paris, according to MM. Belgrand and Le Blanc, contains no lead. Water from seleneferous springs does not attack lead at all. Lime salts in general appear to prevent the water from attacking lead pipes.

Falsification of lycopodium.—Dextrine is mentioned as the adulterant.

January, 1874.

Observation and pharmacological experiments on **quinine tannate.**—Jules Regnauld.—The faults of the various modes of preparation of this substance are shown and a new method of preparation is given in detail. Prepared by this method the substance contains 20·6% quinine having the composition $C_{40}H_{24}N_2O_4, 2(C_{54}H_{22}O_{34})$. 3·5 grammes of this contains as much quinine as 1 gramme of the crystallized sulphate.

New **falsification of quinquina.**—M. Bernatzik.—This consists in sprinkling quinquinas of inferior quality with an alcoholic or acetic solution of quinoidine which causes them to afford by chemical analysis an extremely high percentage of alkaloids. To detect the fraud it is recommended to macerate for half an hour in chloroform and after filtering to evaporate the chloroform down and make tests for quinoidine or in case an acetic solution has been used to wash them with distilled water and then to test the washings.

On **citro-potassic iodide of iron.**—M. Cruse.—All ferric salts without exception form combinations with alkaline citrates, tartrates, and oxalates, soluble in water, and almost entirely insoluble in alcohol. The various reagents, with the exception of hydrosulphuric

acid, give in their solutions no reaction for iron. The mode of forming the ferric iodide compound is given.

New studies on the **pulverulent coal-tar** with charcoal.—Magnes Locheus.—The proportions to be used are—

Charcoal powder passed through fine bolting cloth	1000 parts.
Fresh and very fluid coal-tar	500 "

The method of incorporating the mixture is detailed. For a disinfecting liquid it is recommended to use—

Pulverulent coal-tar	100 parts.
Alcohol at 46° C.	400 "

Poisoning by tin.—M. Pellissié.—The mode of detecting the metal in the tissues and viscera is given. Nitric acid was the oxidizing agent used.

February.

Researches on the **oxygen compounds of nitrogen**, their stability, and their reciprocal transformations.—M. Berthelot.—In sealed tubes a high heat was generally not sufficient to decompose these compounds. The electric spark was in most cases resorted to.

Analytical and toxicological **researches on phenic acid.**—E. Jacquemin.—If to a certain quantity of phenic acid an equal weight of aniline is added, and then sodic hypochlorite, a dark blue solution of sodium erythrophenate is formed, and by this means the author proposes to test for phenic acid in cases of poisoning, etc. The color passes to red on the addition of acids from the liberation of erythrophenic acid. The blue color is restored by addition of alkali. The tribromphenol test and picric acid test, *i. e.*, conversion to picric acid by use of nitric acid, are objected to, as giving the same or smaller reactions with other substances. The coloration test with ferric salts is also objectionable as the reaction is not obtained unless the phenic acid is pure. The reaction with hypochlorite manifests itself with 1 part of phenic acid in 66,000 of water. The modes of making the tests when experimenting on blood, organic tissue, etc., are described in detail.

On **Tolu balsam.**—P. Carles.—Various authorities are cited, some stating that Tolu balsam contains benzoic and cinnamic acids, etc., experiments on the subject proved that it contained only pure cinnamic acid.

Salt in agriculture.—M. Bortier.—Reply to M. Pasteur's communication on the subject. The author claims that in M. Pasteur's experiments he used too large a proportion of salt, and hence obtained only sickly plants. An excess he admits may readily work positive injury; some other points made by M. Pasteur are also met.

On **gum Arabic.**—M. Graeger.—The amount of base saturated by Fremy's gummic acid was found to be extremely small, 96,437 parts of organic acid being saturated by 4·45 parts of potassa or 2·644 parts of lime.

E. W.

Le Technologiste.

No. 397.

Experiments on **phosphorus bronze.**—Details of various experiments with phosphorus bronze as compared with other bronzes, iron, and steel, in all of which the phosphorus bronze stands equal or superior to the best of the other alloys tested. Experiments on the oxidation of the alloy when in sheets exposed to the action of sea water for six months, showed a loss of 3·06 per cent. for best English sheet copper, while phosphorus bronze lost only 1·16 per cent.

Preparation of **gilding powder.**—Three solutions are prepared: No. 1. By dissolving a ducat in aqua regia, as usual evaporating, diluting to 750 c. c., and filtering. No. 2. By dissolving 12 grammes of caustic soda in 200 c. c. of water. No. 3. By dissolving 0·5 grammes starch or milk sugar in 6 c. c. of water, adding 6 c. c. of 50 per cent. alcohol, and 6 c. c. of aldehyde. On mixing the three solutions the gold is slowly precipitated as a very finely divided blackish or brownish powder.

Researches on the **foreign bitter substances in beer.**—M. Kubicki.—A table prepared by the author and M. Dragendorf is given, showing the mode of testing for various substances added to beer to give it a bitter flavor.

No. 400.

Mechanical puddling of M. Pernot.—This consists in an ordinary reverberatory furnace with an inclined hearth, which is made to rotate almost horizontally. Exceedingly good results are claimed to have been obtained with it.

On **phosphorus in steel.**—Ferro-manganese, containing 42 per cent. of manganese, did not lose malleability or other desirable qualities by the introduction of considerable amounts of phosphorus. The result of several experiments at Terrenoire was that phosphorus may be introduced into melted steel on condition that the carbon is eliminated, and the less of carbon that remains the more phosphorus may there be. A steel containing 0·3 per cent. of phosphorus and 0·15 per cent. of carbon is stated to be very malleable, and to furnish rails of good quality.

On the use of **fatty waters from factories.**—M. Vohl proposes to treat waters containing fatty or oily matters from factories with magnesia, thereby precipitating an insoluble magnesia soap, from which the oils, etc., may be recovered by treatment with a mineral acid; magnesia is found to be preferable to lime for this purpose.

New **plant for paper.**—This plant, which is botanically known as one of the genus *Fenela*, grows in profusion in Algeria, where it is known as the "Bedouin cane." In the fall the stems are a mass of fine white fibres, yielding a larger proportion of fibre (80 per cent.) than any other plant used for that purpose in Algeria.

E. W.

Polytechnisches Notizblatt.

No. 6, 1874.

On **bronze** and its uses for coin and objects of art.—S. Elster.—The substance of a lecture delivered before the Berlin Polytechnic Society, giving the results obtained with various alloys of copper with other metals, including lead, nickel, tin, zinc, tungsten, aluminum, and iron, as also with phosphorus. He refers briefly to the fact that a bronze containing 5 per cent. tin and 5 per cent. zinc, such as Blücher's statue in Berlin, becomes covered with a fine permanent patina, while that with less tin and more zinc, like the statue of Frederick the Great, oxidizes with a dull look. The means employed for coloring bronzes artificially are also mentioned.

On the applicability of **corulignon to use in printing** on fabrics.—Prof. Dr. Marx in Stuttgart.—Fischer's experiments on the use of this new product of wood tar for printing on silks and wool, where the color is afterwards developed by potassic dichromate or ferric chloride, indicate that a fine orange color may be obtained in this way. Attempts are at present being made to employ it on cotton, where it is not so easily fixed.

On the disorganization by means of alkalies, of **cotton and flax fibres** after treatment with certain oxidizing agents.—P. Jeanmaire.—Cotton or flax impregnated with a mixture of potassic dichromate and an acid, or with potassic permanganate and exposed to the air, will be found on immersion into an alkaline solution to have lost much of its strength. The same change is produced, but in a much less degree, if the oxidizing agent be potassic ferricyanide.

Photographic prints in platinum, iridium, etc.—Willis, Jr.—The paper is floated on a solution of 1 part potassio-platinic chloride in 48 parts water, dried, saturated with plumbic nitrate solution, 1 to 12, dried a second time, and then painted with a solution of ferric oxalate, 1 to 8, to which a little oxalic acid has been added to render the iron salt soluble. When dry the paper is exposed under a negative, and the weak brown picture produced floated on a hot solution of potassic oxalate, which develops it to a deep black. It is then washed in a dilute solution of oxalic acid, next in "hypo" bath, and lastly in water. Argentic nitrate may be substituted for the lead salt, or platinic bromide with ferric tartrate for the potassio-platinic chloride.

On the preparation of **hydrogen peroxide.**—Julius Thomsen.—Moist hydrate peroxide of barium is treated with dilute sulphuric acid. The commercial article should be dissolved in chlorhydric acid and again precipitated with baryta water.

Solubility of **starch in water.**—August Vogel.—The author finds that starch will dissolve in cold water to an extent sufficient to color iodine tincture a deep blue.

Etching iron and steel.—Professor Kick.—After numerous experiments the author finds that the best solution for etching iron and steel to show its grain, texture, graphite present, etc., is equal parts of hydrochloric acid and water to which is added a trace of chloride of antimony.

Determining the quantity of **caustic soda** in commercial carbonate of soda.—Siegwart.—The method depends on the fact that turmeric paper in a solution of caustic soda acquires the color of red lead, but in a solution of the carbonate has a carmine red color. If a given solution imparts the former color to turmeric paper, it is only necessary to add a normal solution of sulphuric acid from a graduated burette until the paper becomes carmine red. The quantity of caustic alkali present may be readily calculated from the quantity of acid added. The quantity of carbonate of soda may also be determined by continuing to add acid until the solution is neutral. E. J. H.

Bulletin de la Société Industrielle de Mulhouse.

November and December, 1873.

Report on a new method of **determining indigotine** by sodium hydrosulphite.—Dr. Fr. Goppelsrœder.—Criticism of A. Müller's method. The process is highly commended as the best one yet suggested for this purpose in standardizing the solution; it is, however, recommended to use a solution of potassic permanganate, instead of one of ammonio-cupric sulphate as recommended by M. Müller.

January, 1874.

Report on a process of **dyeing and printing with indigo,** invented by MM. Schutzenberger and Lalande.—A. Scheurer.—The vat is made up with sodium hydrosulphite. Made in this way it resists oxidation better than the ferrous sulphate vat, and does not give a large volume of precipitate of ferric oxide and lime which must be allowed to settle. Samples of goods printed by the use of this process accompany the paper. E. W.

Zeitschrift für Zuckerindustrie.

No. 11.

The statement of the **fertilizer trade.**—Dr. A. Petermann (from the *Bulletin de la Station Agricole de Gembloux*).—The value of fertilizers depends chiefly on the amounts of phosphoric acid, potash, and nitrogen which they contain, and also the soluble or insoluble form in which these exist. A table is given showing the solubility of these substances as they exist in the different materials used as fertilizers. The nitrogen may exist, 1st, as nitric acid; 2d, as ammonia; 3d, as organic matter, animal or vegetable; and in these different forms it exercises different effects, so that caution should be used in purchasing a fertilizer which is reported on analysis to contain so and so much nitrogen. The object in treating Peruvian guano with sulphuric acid is explained.

On the **determination of grape sugar** calculated to the amount of cuprous oxide.—Dr. F. Mohr.—The author proposes to take up the cuprous oxide with ferric sulphate, by which an equivalent amount of ferric salt is changed into ferrous salt, and then to titrate with permanganate solution. The ferric sulphate is claimed to be far superior to the ferric chloride for this purpose. The results of thirteen different determinations made in this way are given, showing very concordant results.

No. 12.

Weight and sugar yield of beets during their growth, with regard to using fertilizers, rotation of crops, and climate.—T. Patera.

The **sugar industry in Bohemia** during the year 1872.—The amount of beets worked for sugar in Bohemia in 1872, showed an increase of nearly one million cwt. over that for 1871, while in many other parts of Germany a decrease has taken place.

Vol III., No. 1.

On the **formation of scums** on the surfaces of secondary product syrups.—F. Jicinsky.—The average analysis of these scums was—

Water	. .	14	
Sugar	. .	60·50	
Ash	. . .	14·57	Lime . . 0·10 Alkalies . 11·17
Organic substances		10·93	
		100	

The opinion is expressed that these scums are due to the formation of saccharates. Various phenomena are cited as tending to show the correctness of this supposition.

On a source of **error in determining carbonic acid** with Scheibler's apparatus.—Fr. Stolba.—Metallic iron sometimes exists in boneblack, but more frequently is introduced into it by grinding in an iron mortar. As 1 milligramme of iron affords about a half c. c. of gas, the results may readily be seriously affected. It is recommended, therefore, to avoid the use of iron mortars in pulverizing the black for analysis.

On the preparation and **use of phosphoric acid** in removing lime from sugar liquor, as well as the rational application of superphosphates in sugar factories.—Dr. C. Scheibler.—In an experiment on 400 grms. of molasses containing 0·44 grm. of lime, sufficient phosphoric acid was added to precipitate 0·40 grm. of lime as tribasic phosphate, which was then filtered, and the filtrate and wash water, on being evaporated to the original volume, deposited 1·1 grms. of sugar crystals. The action of the phosphoric acid is by no means simple, as it is almost

never combined with three equivalents of lime in the precipitate, but a portion of it appears to be saturated with an organic nitrogenous principle. In using this agent an analysis should be made for lime, and the amount of phosphoric acid added should never be sufficient to saturate all the lime, or alkaline phosphates would form, which would be lost and unavailable for fertilizing purposes, to which the precipitate may be applied. The amount may be approximately determined by adding known quantities of phosphoric acid to a sample of the molasses so long as a precipitate forms. The advantages of this method of treatment are enumerated.

Method of determining the working of various **methods of pressing.**—The amount of precipitate formed by adding twice the volume of alcohol to a sample of liquor as it runs from the press affords an approximate test.

Using **sugar for preparation of carbonic acid** in the laboratory.—Fr. Stolba.—Yeast is added to a dilute sugar solution, and the carbonic acid developed by the fermentation may be used in the laboratory. By adjustment of the temperature, a slow or rapid evolution of gas may be obtained. When the fermentation is finished the alcohol formed may be distilled off for use.

No. 3.

Practical working of **revivification** by the Pfleger Davis Patent.—J. Perina.—This mode of treating boneblack consists in boiling it up with hydrochloric acid, and then treating with sal ammoniac. The report is on the whole favorable, though it was found to work much better when the black was strongly acidified, allowed to ferment, and then burned about once in a fortnight.

On the hardness and firmness of **sugar carbon.**—F. Monier.—White crystallized sugar, on being heated in a closed vessel to 900° or 1000°, leaves 17 to 18% of carbon of sp. gr. 1·81 to 1·85. The carbon is so hard that it will cut glass, but is very friable on account of its porosity. By pulverizing the carbon and placing it in a bulb, and then saturating it with syrup, sealing the tube and heating again, a pencil of the carbon may be made which is not so friable. If ignited at 1200 to 1300° the carbon will even scratch topaz.

No. 4.

Notes on technical **analytical work with bone black.**—F. Jicinsky.—*Determination of carbon.* Experiments were tried on the determination of carbon by the loss on ignition of the portion insoluble in hydrochloric acid, directly, and after moistening with ammonic carbonate. The results were as follows:—

Loss on ignition after treatment with ammonic carbonate.	True percentage of carbon.	Loss on ignition.	True percentage of carbon.
6·43	5·55	5·75	5·20
7·50	8·04	6·00	5·65
7·32	7·60	5·85	5·55

Microscopical Examination of Boneblack.—A microscopic examination will readily show the presence of charcoal if 2 to 3% has been added for the purpose of adulteration. The charcoal appears acicular and reflects the light, while the bone is a dead black.

Determination of the **refining value of raw sugar** by the areometer.—C. Scheibler.—This consists in removing the non-sugar by use of solution of alcohol and hydrochloric acid saturated with sugar, and then determining the percentage of sugar by dissolving the residue and testing by the areometer. Hydrochloric acid is found to be preferable to acetic acid for this purpose, as it dissolves more readily the salts of the molasses.

No. 5.

The coefficient of **porosity of boneblack.** — A. Heintz. — By weighing a given volume of boneblack and dividing the weight by the weight of the same volume of water, what the author calls the apparent specific gravity is obtained. By weighing the black in water in such a way as to obtain the true specific gravity, a different result is obtained. The quotient of the first divided by the second specific gravity he calls the coefficient of porosity, and suggests that it may be of use in determining the value of a black. E. W.

La Sucrerie Indigene.

No. 17.

Production of sugar in Egypt.—The exports of sugar from Egypt for each year from 1853 to 1872 are given in a tabular form. Up to 1860 the amount exported was a little over 1000 tons for each year, but from that time until 1866 a marked decrease took place, owing, it is stated, to the fact that the existence of the civil war here made the culture of cotton so much more profitable than that of sugar. In 1866 but 49 tons were exported. The next year, however, nearly 2500 tons and thereafter the exportation regularly increased, the amount exported in 1872 having been 20,360 tons. The sugar industry being under the direct control and influence of the viceroy, it is affected by the political vicissitudes of the county more than in other countries.

Beet culture in England.—England has but one beet sugar factory, and one establishment for the manufacture of alcohol from beet juice. The yield does not appear from the figures given to be so good as in France, either as regards the quality of the beets, or the quantities of sugar or alcohol produced per acre.

No. 19.

The **sugar industry in Spain.**—M. Grand.—Detailed account of the state of that industry. The variety of cane yielding the best results is that known there as the "American." The average yield per acre is about 50,000 kilos. The cost of the finished product is on an average 70 francs per thousand kilos.

Practical course in **sugar making.**—M. Vivien.—Exhausted syrup or molasses. *The Marguerite process.* This consists in adding sulphuric acid to convert the salts present into sulphates, and then treating with alcohol which leaves the majority of those salts behind. Details of the expenses are given. *Purifying molasses by osmose.* The general principles of diffusion and osmose are dwelt upon.

No. 20.

Chemical fertilizers applied to the beet.—M. Corinwinder.—The results of three experiments led to the following conclusions:—

1st. Sodic nitrate used in the proportion of 600 kilos per hectare gave very satisfactory results, attaining 38,000 kilos (of sugar) per hectare. It must not be forgotten, however, that the experiments were conducted on soil which had already attained considerable fertility.

2d. Ammonic sulphate, of which 500 kilos were used to the hectare, gave the same results in weight (of sugar) as the sodic nitrate, with but few exceptions.

3d. The addition of phosphate and potassium salts to the above fertilizers did not sensibly increase the yield of beets.

The author does not feel inclined to prescribe systematically the use of sodic nitrate, but recommends that it be used with discretion. Formulæ for two mixtures to be used as fertilizers and the results obtained on a trial with them are given.

The destruction of **insects hurtful to the beet.**—Extracts from the paper of the Marquis of Havrin court read before the Central Society of Agriculture of Pas-de-Calais. The May bugs or white worms were found to be the principal pests. These were shaken from the plants and shrubbery on which they had collected, and killed with boiling lime-water. To further the destruction of these bugs the workmen were offered a certain sum for every litre of bugs thus collected. The carcasses were found to make a very fair manure. Gas liquor and sulphuric acid were found to be efficient in destroying these pests. 100 parts of the carcasses of bugs killed by boiling water and not dried were found to be composed as follows:—

Water	73·60
Nitrogen	2·81
Organic matters	22·02
Phosphates	0·40
Other mineral constituents	1·17
	100·00

No. 21.

Practical course in **sugar making.**—M. Vivien.—*Eissfeld's mode of revivifying boneblack.* This consists in allowing the black to ferment, and then washing it with acid, then with water, finally with a dilute solution of ammonia and drying by steam.

No. 22.

Practical course in **sugar making.**—M. Vivien.—*Clarification of syrups with blood and boneblack; Lime clarification. Clarification with alkaline carbonates.* M. Vivien's process, which consists in precipitating the lime by use of sodic or potassic carbonate. *Carbonatation*, treating the syrups containing much lime with carbonic acid until the lime is entirely precipitated. *Hamelle black.* E. W.

RECENT CHEMICAL PATENTS.

April 28th, 1874.

150,177.—Manufacture of Artificial Stone.—T. Miller, Syracuse, N. Y. Treating artificial stone with combined gases of carbon and sulphur.

150,178.—Artificial Stone.—T. Miller, Syracuse, N. Y. Soluble glass, carbonate of ammonia, sand, gravel, etc.

150,194.—Composition Moulding.—A. Schmidt, Louisville, Ky. Fine tan bark, egg shells, slaked lime, glue, and linseed oil.

150,303.—Water-repellent Dubbing for Leather.—E. F. Dietericke, Philadelphia. Fatty matter, caoutchouc and a compound of alumina, insoluble in water, with or without paraffine or stearin.

150,366.—Extracting Quicksilver from Sulphur Ores.—J. P. Sieveking, Altona, Prussia. Treating cinnabar with subchloride of copper.

150,375.—Preserving Green Corn, etc.—D. G. Thompson, Minneapolis, Minn. Immersing it in water, salt, and sugar.

May 5th.

150,387.—Manufacture of Iron and Steel.—H. M. Baker, Williamsburg, N. Y. The molten metal flows into a crucible, where it is crossed with a volatile oxidizing agent, as steam or nitric acid vapor, followed by a similar treatment with reducing agents, as hydrocarbons, or non-volatile matter, introduced into the crucible.

150,393.—Fuel from Coal Dust and Slack.—W. Blood, Boston, Mass. Coal dust mixed with lime, slaked in a solution of soda.

150,405.—Process of Double Tanning.—E. F. Dieterichs, Philadelphia. Treats tanned skins with solution of alum and quillaya bark, dries them, and immerses in decoction of quillaya bark, flaxseed, and potash or soda.

150,427.—Dyeing with Indigo.—G. Molt, Millbury, Mass. Solution of indigo and decoction of hops.

150,428.—Blasting Powder.—G. W. Mowbray, North Adams, Mass. Nitro-glycerin mixed with finely divided mica or muscovy talc.

150,504.—Process for the Manufacture of Paper.—J. M. Allen, Marion, Mass. Treating bark of coniferous trees with steam or water and without alkalies or acids, thereby exhausting the tannic acid in vessels having no affinity for tannic acid.

150,508.—Caustic Alkali Package.—B. T. Babbitt, New York Coating with resin.

150,537.—Artificial Fuel.—S. H. Daddow, St. Clair, Pa. Coal, lime, peat, and soluble glass.

150,546.—Manufacture of Iron and Steel.—C. M. Tessie du Motay, Paris, France. Phosphoric steel, an alloy of iron, manganese, and phosphorus.

150,548.—Method of Preventing Alterations of Checks, etc.—L. G. Ehrhardt, Philadelphia. A compound of sulphate of iron, gallic acid, gum sandarac, and red or yellow prussiate of potash is applied in a dry state to the surface of the check.

150,559.—Manufacturing fibre from Pine Leaves.—C. Fulton, Hoboken, N. J. Macerate leaves, and boil with water, potash, sulphuric acid, and chlorine water until resinous and tannic constituents separate.

150,562.—Fire-proof Paint.—L. S. Gibson, Jamestown, N. Y. Alum, sugar of lead, and a silicate.

150,576.—Purifying Iron.—W. W. & R. H. Hubbell, Chester, Pa. A mixture of clay, saltpetre, lime, salt, and charcoal is placed in the bottom of a receiver upon which the molten metal is poured.

150,614.—Treating Refined Petroleum Oils.—J. Reese, Pittsburg, Pa. Subjecting to the action of a vacuum without heat.

150,618.—Manufacture of Gas.—W. D. Ruck, London, England. Steam is passed through a series of retorts, filled with carbonaceous matter, and then passed through a liquid hydrocarbon.

150,636.—Water-proof Composition.—J. A. Turner, Manchester, England. Equal parts of pitches from purification of cotton-seed oil and paraffine oil.

150,652.—Oil-proof Composition for Leather.—C. E. Brigham, Marlborough, Mass. Caustic alkalies with sugar of lead and gum shellac, with or without oil of cassia.

May 12th.

150,675.—Refining Bullion.—T. H. Bonsfield, San Francisco, Cal. Treats granulated crude bullion with mixture of nitric and sulphuric acids.

150,698.—Making Parchment Paper.—E. Metzger, Pittsburg, Pa. Places paper in a bath of sulphuric acid and salt, then washes and immerses in an alkaline bath.

150,722.—Artificial Coral for Jewelry.—D. D. Smith, Syracuse N. Y. Gun-cotton, gum copal, alcohol, perchloride of tin, protochloride of tin, perchloride of gold, magnesia, and oxide of mercury.

150,838.—Manufacture of Building Material.—J. Deleon, Paris, France. Magnesia, chloride of magnesium, and carbonate of soda, mixed with limestone and sand.

150,841.—Preserving Wood.—F. Daboure, New York. Saturating with tannic acid and injecting acetate of iron.

150,867.—Preparing Salicylic and other Acids.—Hermann Kolbe, Leipsic, Germany. The artificial production of salicylic and isomeric and homologous acids by the action of carbonic acid on carbolic or cresolic acids, or a mixture of them, in presence of alkalies and alkaline earths.

May 19th.

150,957.—Precipitating Copper with Tin Scrap.—T. Sterry Hunt, Boston, Mass. Precipitating copper with tin scrap and the recovery of the tin by precipitation as oxide in a solution containing protochloride of copper and a sulphate.

150,994.—Coating Stoneware to protect it from Acids.—O. Zwietusch, Milwaukee, Wis.—Boiling in a solution of paraffine.

151,078.—Insect Destroying Compound.—J. D. Braman, Galveston, Texas.—Arseniate of soda, dextrin, and water.

151,119.—Artificial Vanillin.—W. Haarmann, Berlin, Prussia. Heat coniferin in a mixture of chromate of potassa, sulphuric acid, and water. Remove the vanillin by shaking with ether, and purify by repeated crystallization.

May 26th.

151,219.—Manufacture of Dry Soluble Silica.—R. Guenther, Oshkosh, Wis. Precipitates silica with hyposulphite of soda.

151,386.—Manufacture of Sulphates of Soda and Potassa.—J. Hargreaves and T. Robinson, Widnes, England.—Passing sulphurous acid gas, air, and watery vapor through chloride of sodium or potassium in a high tower.

151,424.—Artificial Fuel.—C. C. F. Otto, Syracuse, N. Y.—Coal dust, pitch, benzine or petroleum, and nitrate of soda.

June 2d.

151,476.—Compound for Separating Wool from Rags.—J. F. Collins, New Haven, Conn.—Water, alum, borax, soda, and muriatic acid, or water, charcoal, borax, Peruvian guano, and muriatic acid.

151,497.—Manufacture of White Lead.—A. P. Meylert, New Britain, Conn. Conveying carbonic acid from lime-kilns to corroding chambers.

151,623.—Refining Petroleum.—N. Root, Franklin, Pa. Mixing with rosin, potash, and baryta.

151,662.—Process for making Paper Pulp from Varieties of Palm.—J. P. Herron, Washington, D. C. The material is digested, under pressure, with weak solution of alkali, naphtha, benzine, or soap; then ground and bleached.

June 9th.

151,762.—Preventing Mildew in Fabrics from Vegetable Fibre.—A. Davidson, Brooklyn, N. Y. Application of a tannic or astringent solution, or of an alkali.

151,763.—Extracting Silver, Gold, and other Metals from their Ores.—J. Douglas, Jr., Quebec, Canada, T. Sterry Hunt, Boston, Mass., and J. O. Stewart, Georgetown, Colorado Terr. If ores do not contain copper, add copper pyrites and roast to convert the baser metals into sulphites or sulphates, and add salt to convert into chlorides.

151,799.—Production of Lead Paints.—C. C. Ralgar, San Francisco, Cal. By mixing lime and sulphate of lead.

151,879.—Process of treating Moss.—M. Holtzmacker, New Orleans, La. Treating in a bath of logwood, copperas, and cider vinegar.

151,905.—Manufacture of Fertilizers from Nightsoil.—G. E. Noyes, Washington, D. C. Mixing with hydraulic cement or calcined plaster and sulphuric acid, to form solid bricks.

June 16th.

151,958.—Manufacture of Floor Cloth and Imitation Leather.—J. Charles, London, and C. Taylor, Ponder's End, England. Treating cloth with boiled linseed or other drying oil, previously acted upon by an alkaline earth, as lime.

152,126.—Process of Purifying and Clarifying Saccharine Juices and Syrups.—J. V. P. Lagrange, Paris, France. By the use of the double phosphate of ammonia and baryta.

152,132.—Manufacture of Steel.—J. Leighton, Jersey City, N. J. In one ton of metal, bay-salt 15 lbs., clay 14 lbs., manganese 5 lbs., soda ash 1 lb., borax 1 lb., in connection with a specified mixture of Port Henry iron ore and Port Oram, Stanhope, and Baltimore pig irons.

152,167.—Artificial Stone.—E. L. Ransome, San Frascisco, Cal. Excess of moisture in such stone is removed by a hot bath of silicate of soda or potash.

152,187.—Bating and Cleansing Hides.—W. Stack, Sussex, Canada. Bran, vitriol, and salt for bating hides, and tar-water and soda for cleansing them.

June 23d.

152,269.—Manufacturing Carbonic Acid.—H. Beins, Gemingens, Netherlands. Heating carbonate of lime in a closed retort and conducting the gas into a refrigerated reservoir, and condensing it to a liquid.

152,399.—Extracting Metal from Ore.—D. Windenleff, Washington, D. C. Manufacturing copper to oxide and reducing it to metallic state by heat and gas. Separating silver and gold, by converting silver to chloride of silver and then reducing this to metal by heat and gas. Separating copper from the other metals by reducing all to metal and then treating with dilute sulphuric or muriatic acid.

June 30th.

152,617.—Refining Iron.—R. S. Dillon, Detroit, Mich. The use of a mixture of chloride of sodium, hydrate of lime, and clay.

152,689.—Enamelled Dial and other Plates.—J. H. Robinson, Liverpool, England. White lead, arsenic, flint-glass, saltpetre, borax, and ground flint are powdered, mixed, and melted; then cooled, powdered and placed on face of plate to be fused in a furnace.

BOOKS RECEIVED.

A Treatise on Food and Dietetics, physiologically and therapeutically considered; by F. W. Pavy, M.D., F.R.S. Philadelphia, 1874.

This work was originally intended to form a supplement to the author's former treatise on "Digestion and its Disorders;" but as the subject seemed of sufficient importance to be treated separately, it was determined to make it an independent publication. A principal motive for this change of intention seems to have been supplied by the new views which have arisen within the last few years on the significance of the nitrogenous matters, as ingredients both of the food and the tissues, in comparison with the non-nitrogenous substances, and on the part which they take in the production of muscular activity. These views are fully adopted by Dr. Pavy and defended with much earnestness in the earlier portion of the book. After arranging the different kinds of nutritive substances in a very useful and practical classification, the author goes on to consider each class separately. The division which he adopts is that into the nitrogenous principles, the fats (which by a stretch of chemical nomenclature he calls "hydrocarbons"), the carbohydrates, and the inorganic materials. The nitrogenous alimentary principles are those which naturally receive the first consideration. Their principal varieties are well described, and the digestive process by which they are liquefied in the alimentary canal is sketched in a rapid, but distinct and satisfactory manner. The relations of nitrogenous matter to force-production are next taken up, and to this question, as a prominent one among the more recent topics of physiological discussion, a large space is devoted. According to the view heretofore held the muscular substance undergoes a destructive metamorphosis during active contraction, the excretion of urea being at the same time the consequence and the measure of both the action and decomposition of the contractile tissue. As we have already intimated, Dr. Pavy is fully convinced that this view is erroneous, and that the new opinion is the correct one, which denies the existence of any special correlation between muscular work and the excretion of urea; regarding the muscular fibre and its nitrogenous constituent only as the instrument of the contractile explosion, while it is the oxidation of the fats or carbohydrates which actually supply its force. In this view, the muscular fibre is to be regarded only as a sort of gunbarrel, which is not perceptibly altered by the discharge; while the fats and carbohydrates are the gunpowder, which is used up in furnishing the explosive force. Fick and Wislicenus, who may be said to have originated this doctrine, compare the nitrogenous muscle-fibre and the non-nitrogenous elements of food respectively to the machinery and the fuel of a steam-engine, the machinery of which is not visibly deteriorated by a day's work, while coal and water are consumed in exact proportion to the amount of force produced. Notwithstanding the cleverness, however, of this illustration, it must be acknowledged that its ingenuity is its chief merit. It is a comparison that *seems* to make the matter plain, but does not in reality do so; and as soon as we try to follow it out it leaves the mind unsatisfied. In the action of a steam-engine all the details of the process are plain to us. The combustion of the coal, the heating of the water, the production of the steam, and the movement of the piston-head under the impulse of its expansion, follow each other in a perfectly simple and intelligible order. But how is it with the muscular fibre? By what imaginary or supposable direct process can the oxidation of fat or sugar in the animal fluids cause the contraction of a muscular fibre? We are by no means disposed to deny the possibility of such a causation; it is among the things that are unknown and of course undeniable. But we wish to point out that the illustration of the steam-engine before mentioned does not really illustrate the matter except in a very superficial way; and not at all so, if we expect it, as an illustration, to aid in making a somewhat obscure hypothesis clearer to the mind. The experiments of Fick and Wislicenus, indeed, were themselves quite disproportionate to the extensive theoretical structure which the authors raised upon them. These experiments extended only over rather less than thirty-six hours, eight of which were occupied in the ascent of the Faulhorn, and consisted in the examination of the experimenter's urine in order to determine whether the unusual muscular exertion was accompanied by an increased excretion of urea. So far, the experiment was well conceived; but "in order to simplify it," the observers restricted themselves at the same time to a non-nitrogenous diet. Unfortunately this did not simplify the matter, but, on the contrary, complicated it, since it has long been known that a non-nitrogenous diet at once produces a diminution in the excretion of urea independently of any other conditions. However, this plan was adopted by the two Swiss professors, probably with a view to their elaborate calculation of the "force and heat-units" produced in the ascent, and an estimate of how far they were attainable from the disintegration of their muscular tissue, or their non-nitrogenous food respectively. No doubt these calculations were a laudable attempt in the right direction: and similar estimates based on the comparison of exact numerical quantities, will be in the future a fruitful source of physiological discovery, but at present we are not in a position to use them with confidence. When we are dealing with numbers the whole value of the result depends upon their actual precision, at least within reasonable limits, and it is certainly discounting our knowledge to a very imprudent degree to rest any decisive, physiological doctrine upon such an estimate of heat and force-units as that of Fick and Wislicenus. We are not sure that Dr. Pavy is not sometimes disposed to be enticed too easily in the same direction, as, for instance, where he estimates the value of a nutritive substance in the production of force precisely according to its power of producing heat by oxidation. "Thus," he says (page 87), "as a force producing agent, if we are right in taking capacity for oxidation as a measure, albumen has about half the value of fat, and a greater value than both sugar and starch." It is certain that the "capacity for oxidation" is not taken as a measure of the nutritive value of the flesh and fat of beef, at least by dealers and consumers, since the nitrogenous flesh will alone command in the market, weight for weight, from two and a half to three times the price of the non-nitrogenous fat. Dr. Pavy's book passes in review all the more important articles of animal and vegetable food, their varieties, preparation, and the adulterations or contaminations to which they are liable, and ends with a carefully written section on the Principles and Practice of Dietetics. It is the most complete and valuable book at present on these subjects, in the English language, being of a much higher grade than several of the treatises on food which have appeared within a few years past.

Jahres-bericht über die leistungen der Chemischen Technologie. Herausgegeben von Rudolf Wagner. 1873.

No reader of the CHEMIST needs to be reminded of the invaluable, or, we might say, absolutely essential character of such works as the above named. At the present rate of progress in science and its applications, and with the vast number of technical journals in all languages among which original workers distribute their publications, the entire time of any one would be fully employed in simply keeping up with the general progress in such a subject as this. The value of such a book as the present, however, depends entirely on the confidence which one may repose in the ability and diligence of its author, since it would be of little use if requiring to be supplemented by individual examination. In this regard we have only to look at the name of Rudolph Wagner, and we will feel assured from a long previous experience that all has been done thoroughly and well. We need only add that the present volume corresponds and does justice to its predecessors in the same series.

Figuier—L'Année Scientifique et Industrielle. Par Louis Figuier. Dix-septième année, 187_. 12mo. paper. Paris, 1874.

Fremy—Le Metal à Canon. Par E. Fremy. 8vo. paper. Paris, 1874.

Reybaud—Le Fer et la Houille suivis du Canon Krupp, et du familistere de Guise. Par Louis Reybaud. 8vo. paper. Paris, 1874.

Siemans—Fuel. By C. Williams Siemans, D.C.L.; to which is appended the Value of Artificial Fuels as compared with Coal, by John Warmald, C.E. 16mo. boards. (No. 9 Van Nostrand's Science Series.) New York, 1874.

Simmonds—Waste Products and Undeveloped Substances; a Synopsis of Progress made in their Economic Utilization. By P. L. Simmonds. 12mo. cloth. London, 1873.

Armstrong—Introduction to the Study of Organic Chemistry, the Chemistry of Carbon and its Compounds. By Henry E. Armstrong, Ph.D. 12mo. cloth. (Text-book of Science Series.) London, 1874.

Thorpe and Muir—Qualitative Chemical Analysis and Laboratory Practice. By T. E. Thorpe and M. M. Pattison Muir. 12mo. cloth. London, 1874.

Reynolds—Six Short Lectures on Experimental Chemistry, introductory to the General Course. By J. Emerson Reynolds, F.C.S. 8vo. cloth. Dublin, 1874.

Will—Tables for Qualitative Chemical Analysis, with an Introductory Chapter on the Course of Analysis. By Prof. H. Will. Second American, from the ninth German edition. Edited by Chas. F. Himes, Ph.D. 8vo. cloth. Philadelphia, 1874.

Bunsen, R.—Anleitung zur Analyse d. Aschen u. Mineralwasser. Heidelberg.

Handwörtenbuch, Neues der Chemie—Bearb. u. red. v. H. v. Fehling. I. Bd. 11. Lfg. Braunsch.

Heppe, Dr. Gust.—Die chemischen Reactionen d. wichtigsten anorganischen u. organishen Stoffe. Tabellen in alphabetischer Anordnung z. Gebrauche bei Arbeiten im Laboratorio. Leipz. 1. Lfg.

Kubel, W.—Anleitung zur Untersuchung v. Wasser, welches zu gewerbl. u. häusl. Zwecken oder als Trinkwasser benutzt werden soll. 2. Aufl. Braunschweig.

Chemisch-techn. Repertorium—Von der Emil Jacobsen. Bd. XII. Jahrg. 1873. Halbjahr I. Berl.

Ritter—Manuel de Chemie Pratique, Analytique, Toxicologique, Zoochimique, à l'usage des etudiants en médecine et en pharmacie. Par E. Ritter. 12mo. paper. 125 illustrations. Paris, 1874.

Rodwell—The Birth of Chemistry. By G. F. Rodwell, F.R.A.S. With numerous illustrations. 12mo. cloth. London, 1874.

Du Moulin—Manuel Elementaire de Photographie au Collodion humide. Par Eug. Du Moulin. 12mo. paper. Illustrated. Paris, 1873.

Clinical Notes on Nervous Diseases of Women. By Wm. B. Neftel, M.D. 8vo. 24 pp. New York, 1874.

On the Lignites and Plant-beds of Western America. By J. S. Newberry. 8vo. 6 pp.

Circles of Deposition in American Sedimentary Rocks. By J. S. Newberry. 8vo. 14 pp.

Fifteenth Annual Report of the Inspector of Milk. City Document, No. 36. By Henry Faxon, Inspector. 8vo. 35 pp. Boston, 1874.

Yesso Coals. Geological Survey of Hokkaido. By Henry S. Munroe, E.M., Assistant Geologist and Mining Engineer to the Kaitakushi of Hokkaido. 8vo. 39 pp. Tokei, 1874.

Assaying by the Spectroscope. Experiments made in the U. S. Mint. Communicated by Mr. W. E. Du Bois. 8vo. 11 pp. Philadelphia, 1874.

Origin and Properties of the Diamond. By A. C. Hamlin. 8vo. 5 pp.

Viaje a la Caverna de Cacahuamilpa. By Mariano Bárcena. 8vo. 31 pp. Mexico, 1874.

On the Age of the Copper-bearing Rocks of Lake Superior. By Roland D. Irving. 8vo. 12 pp. New York, 1874.

The Problems and Future of Pharmacy in Germany. By Frederick Hoffmann, Ph.D. 8vo. 12 pp. Philadelphia, 1874.

Board of Health of the City of New Haven. 8vo. 32 pp. New Haven, Conn., 1874.

Medical Literature of Kentucky. By Lunsford P. Yandell, M.D. 8vo. 52 pp. Louisville, Ky., 1874.

Report of the State Librarian to the General Assembly relating to the Registration of Births, Marriages, and Deaths, and to Divorces for the year ending December 31, 1873. 8vo. 34 pp. Hartford, Conn., 1874.

Reply to Dr. T. Sterry Hunt. By F. A. Genth. Pamphlet 8vo. 2 pp.

Fifth Annual Report of the Bureau of Statistics of Labor. Pamphlet 8vo. 281 pp. Boston, Mass., 1874.

Notes on the Flow of the West Branch of the Croton River. By J. James R. Croes, C.E., Member of the American Society of Civil Engineers. Pamphlet 8vo. 11 pp. New York, 1874.

Contribution to the Study of Yellow Fever. By John M. Woodworth, M.D. Pamphlet 8vo. 51 pp. Washington, D. C., 1874.

Hospitals and Hospital Construction. By John M. Woodworth, M.D. Pamphlet, 8vo. 13 pp. Washington, D. C., 1874.

Annual Report of the Supervising Surgeon of the Marine Hospital Service of the United States for the Fiscal Year 1873. By John M. Woodworth, M.D. 8vo. 154 pp. Washington, D. C., 1873.

Nomenclature of Diseases. By John M. Woodworth, M.D. 8vo. 210 pp. Washington, D. C., 1874.

Proceedings of the American Association for the Advancement of Science. Twenty-second Meeting, held at Portland, Maine, August, 1873. Pamphlet, 8vo. 448 pp. Salem, Mass., 1874.

The Physiology of Man; designed to represent the Existing State of Physiological Science as applied to the Functions of the Human Body. By Austin Flint, Jr., M.D. 8vo. 517 pp. New York, 1874.

Hints for Health. By J. Sherwood Stocker, M.D. Lond. 8vo. 47 pp. London, Eng., 1874.

Address of Joseph M. Toner, M.D., before the American Medical Association. Pamphlet, 8vo. 20 pp. Philadelphia, Pa., 1874.

Lecture on Strain and Over-action of the Heart. The Toner lecture. By J. M. Da Costa, M.D. Pamphlet, 8vo. 28 pp. Philada., Pa., 1874.

BREVITIES.

Dr. C. W. Siemans, F.R.S., received the Albert Gold Medal of the Society of Arts this year.

A Piece of Native Gold, weighing two hundred kilogrammes, and worth £24,000, has been found in French Guiana, and sent to Paris for exhibition.

John Phillips, Professor of Geology in the University of Oxford, England, died on the 24th of April last, at the age of seventy-three.

The Chemical Composition of the Wood of Acrogens has been determined by George W. Hawes. Excluding the ash the composition of the vegetable tissues is as follows:—

	C.	H.	O.	N.
Lycopodium dendroidum	48·79	6·62	43·15	1·44
" complanatum	48·35	6·61	43·09	1·95
Equisetum hyemale	47·54	6·74	44·45	1·27
Aspidium marginale	47·18	6·35	44·30	2·17
Cryathea canaliculata, section	49·08	6·66	43·05	1·21
" " cortical part	52·04	5·26	41·18	1·52

Photographic Dry Plates can be prepared by daylight, according to Prof. C. F. Himes, as follows: Glass plates coated with ordinary brown-iodized negative collodion are sensitized in the usual argentic nitrate bath, in bright daylight, and are then thoroughly rinsed in distilled water to remove the larger portion of adhering silver solution. They are then flowed with a five per cent. solution of potassic iodide, or are exposed to the action of sunlight for several hours, and then dried. Such plates are insensitive to light, and may be made sensitive by immersing them in the dark in a solution of tannin, fifteen grains to the ounce of water for a few minutes. Being then dried they will remain sensitive for months.

On the Presence of Lithium in the Soil of Limagne and the mineral waters of Auvergue.—Truchot.—The author shows that the soil of Limagne contains from 31 to 132 milligrammes of carbonate of lithium to the 100 grammes of earth. It also contains ·5 to ·6 gramme of potassa. The author has succeeded in making quantitative determinations of lithium by means of the spectroscope—using solutions of known strength as standards.

Wheelerite, a New Fossil Resin, of a yellowish color, occurs in the cretaceous lignite beds of northern New Mexico. An analysis, by O. Loew, gave carbon 73·07, hydrogen 7·95. Alcohol dissolves the greater portion; upon evaporating the clean solution a resin remains, of a yellowish color, very brittle, and strongly electric in friction. It melts at 154° C. It is soluble in ether, less so in bisulphide of carbon.

Some Oil Statistics.—We give below the number of wells drilling and the daily average production of each month from 1869 to 1873 inclusive. It will be seen that only sixty were drilling in December last, less than one-half the number at any previous time during the five years given:—

NO. WELLS DRILLING.

	1869.	1870.	1871.	1872.	1873.
January	378	364	167	339	261
February	341	388	173	335	249
March	334	395	176	298	227
April	292	432	254	277	227
May	312	441	295	293	228
June	345	463	296	298	295
July	305	349	316	315	340
August	310	319	342	330	267
September	315	306	438	264	197
October	331	305	479	shut down	163
November	360	206	459	354	137
December	346	191	388	333	60

DAILY AVERAGE PRODUCTION.—NO. BBLS.

	1869.	1870.	1871.	1872.	1873.
January	10,102	12,634	14,690	17,070	20,407
February	9,967	11,917	13,740	17,348	21,725
March	9,891	12,385	14,118	16,024	21,461
April	11,067	12,974	14,186	16,626	21,384
May	10,153	14,165	15,218	18,505	25,044
June	11,334	14,817	15,699	17,982	26,449
July	11,697	16,969	16,898	18,349	27,893
August	12,157	17,777	17,078	18,792	30,198
September	12,645	19,489	16,753	15,863	31,809
October	13,071	20,158	16,741	....	30,403
November	13,317	17,414	16,862	21,287	33,045
December	12,844	16,431	16,531	20,825	34,980

—*Titusville Courier.*

THE AMERICAN CHEMIST.

Vol. V. No. 5.

REACTIONS WITH META-PHOSHATE OF SODA.

BY P. CASAMAJOR.

Carbonate of soda, borax, and salt of phosphorus, which were introduced by Cronstedt in blowpipe determinations, are still the only substances used as general reagents, or reagents that are applied to the detection of a great number of substances. All the others used in researches of this nature have a limited field of application: as, for instance, the cobalt solution, which is one of the most useful, and which can only be employed advantageously in determining alumina, magnesia, and zinc.

Berzelius has well called it a remarkable fact that these three reagents, which are still the best substances used in these researches, should have been introduced when blowpipe science was still in its infancy.

Next to these three, the reagent which has the widest range of application is bisulphate of potassa, which serves to detect hydrochloric acid, bromine, iodine, hydrofluoric acid, nitric acid, boracic acid, and lithia. This reagent has been introduced in blowpipe tests since the publication of the excellent work of Berzelius: *On the Use of the Blowpipe in Chemical Analysis and Mineralogical Determinations.*

To Berzelius we owe a process for the detection of hydrofluoric acid, by setting it free in a glass tube by heating with salt of phosphorus previously melted. He has also given us processes for the determination of hydrochloric acid and iodine by the use of salt of phosphorus previously melted with oxide of copper into a bead, to form chloride and iodide of copper, which give characteristic colors to the portions of the flame surrounding the bead.

I am not aware that, beyond these three processes, any attempt has been made to use salt of phosphorus for the detection of the bodies that are now determined by the use of bisulphate of potassa. This inquiry has, however, appeared to me to be one of great importance, because salt of phosphorus, being one of the three indispensable reagents, is in all probability to be found with every chemist who uses a blowpipe, even if the special reagents, which have a more limited field of application, should be omitted.

It may be useful to recall to mind that the salt of phosphorus or microcosmic salt is a tribasic phosphate of soda, ammonia, and water, containing four equivalents of water of crystallization. When gently heated, it loses its water of crystallization; if the temperature is raised, it loses its ammonia and basic water and becomes meta-phosphate of soda, which is the reagent really employed in blowpipe tests whenever salt of phosphorus is mentioned. When meta-phosphate of soda is heated with bodies capable of giving volatile acids, it acts in the same manner as bisulphate of potassa: hence it may be used to determine hydrochloric acid, bromine, iodine, hydrofluoric acid, nitric acid, and boracic acid. Lithia, which may be determined by means of bisulphate of potassa in some exceptional cases, must be left out of this list, as the color of the lithia flame cannot be seen in presence of the sodium flame. This difficulty might be overcome by viewing the flame through a hand spectroscope, but this can hardly be considered as one of the avowed methods of blowpipe chemistry.

For all these determinations, bisulphate of potassa is a more convenient reagent than salt of phosphorus, on account of the necessity of previously converting the latter into meta-phosphate of soda, while the bisulphate may be used without any previous preparation. This objection to salt of phosphorus would be removed by converting a certain quantity of it into meta-phosphate and bottling for future use. If moderately well corked the meta-phosphate will remain hard and glassy, but when exposed to moist air it will become syrupy, while under the same circumstances crystals of bisulphate become soft but keep their shapes. Phosphoric acid may be used in the same manner as meta-phosphate of soda, but it becomes syrupy much more easily than the meta-phosphate and is so liquid when heated that it is difficult to keep it on the platinum hook.

Almost all the reactions treated of in this paper take place in glass tubes open at both ends, not less than two inches long and of about one-quarter inch diameter.

A small quantity of salt of phosphorus is placed in the tube about one-quarter inch from one of the ends; the tube is to be held horizontally, and the portion containing the salt of phosphorus gently heated by being placed a few inches above any ordinary flame. The salt of phosphorus melts very readily, and, unless the heat be applied very cautiously at first, it will sputter and be projected from the tube, particularly if the diameter be too small.

After heating gently for a little while, the ebullition stops, and the temperature may be increased until no more bubbles rise from the liquid drop of meta-phosphate of soda. When the meta-phosphate has been brought to this condition, the tube is to be freed from any water or ammonia by bringing the cool end before the mouth of the operator, who with a few puffs may clear the tube of ammonia vapors. This is an indispensable operation, as, while ammonia is present in the tube, none of the reactions can take place. If any liquid should adhere to the sides, it may be removed by bibulous paper before proceeding with the test.

The reactions of the bodies mentioned with meta-phosphate of soda are as follows:—

Hydrochloric acid.—A substance to be tested for hydrochloric acid should be powdered and laid in the glass tube on top of the solidified drop of meta-phosphate of soda. By the application of heat the powder will mix with the meta-phosphate, and hydrochloric acid

will be given off, which may be recognized at the other end of the tube by its characteristic smell and by its turning litmus paper red. If a small quantity of powdered peroxide of manganese is added, chlorine will be given off, known by its characteristic smell, by its giving a violet tint with ozone paper (one part iodide of potassium, ten parts starch), and by its bleaching litmus paper.

Bromine.—A substance containing bromine, treated in the same way, will give hydrobromic acid, which has a characteristic smell and turns blue litmus paper red. If peroxide of manganese is added, bromine is given off in characteristic brownish-yellow fumes, which may best be seen by holding the tube before the eye so as to have a thickness of vapor equal to the length of the tube. Ozone paper will give a purple color, and litmus paper will be bleached. When bisulphate of potassa is used to detect bromine, a certain quantity of this element is formed in the tube, even without the aid of peroxide of manganese: this is accompanied by the formation of sulphurous gas; but the quantity of bromine formed is not sufficient to show bromine vapors in the tube. A mist is formed which has acid properties and which turns ozone paper purple. When a bromide is heated with meta-phosphate of soda without peroxide of manganese, a mist is also formed in the tube, which is acid, but which has no action on ozone paper, and which reddens but does not bleach litmus paper.

Iodine.—An iodide, heated in the same manner with meta-phosphate of soda, gives purple fumes of iodine, which may be seen by looking through the sides of the tube. If there should be very little iodine in the substance under examination, it may be useful to look at the vapors through the whole length of the tube, as described for bromine. A piece of starched paper, or any starched linen or cotton fabric which may be at hand, will give the characteristic violet color if iodine is present, by being held before the cold end of the tube.

Hydrofluoric acid.—The process used in this case is materially the same as the one given by Berzelius. I have found, however, that much less heat is necessary than when the flame from the blowpipe is sent into the tube. We may operate for fluorides as we have already described for chlorides, bromides, and iodides.

If the tube is heated by simply being held at the apex of the ordinary flame of an oil lamp, or, better still, as being cleaner and more convenient, over a non-luminous flame such as that of a spirit lamp, a white ring will be shown very plainly above the meta-phosphate. To make it certain that this appearance is due to corrosion, the tube should, when sufficiently cooled, be left in water, which will dissolve the meta-phosphate in a few minutes, with the help of a little rubbing with a little stick or stiff piece of paper.

The inside should afterwards be dried thoroughly with bibulous paper, when the marks made by hydrofluoric acid on the glass will appear. By rubbing the inside of the tube with a metallic wire we obtain further conclusive evidence as to whether the white appearance in the tube is due to corrosion.

Brazil-wood paper, exposed to the fumes of hydrofluoric acid at the cold end of the tube, gives a straw-yellow color, which is characteristic of hydrofluoric acid. Other acids, when sufficiently diluted, give a yellow color with Brazil-wood paper, but the color is not so vivid and the reaction takes time, while the change of color by the action of hydrofluoric acid is immediate.

Nitric acid.—Nitrates heated with meta-phosphate of soda in the glass tube give red fumes of hyponitric acid, which may be seen by looking through the sides. If the substance under examination contains very little nitric acid, it may be necessary to look through the whole length of the tube to see the red fumes.

Boracic acid.—The process for the detection of boracic acid is the same as when bisulphate is used. We find it recommended in books, to mix the bisulphate with fluor-spar and form a bead on the platinum hook, to which the substance under examination is afterwards added.

If a borate is present, there will be given the green color due to boracic acid. This reaction is founded on the easy formation and great volatility of fluoboracic acid, which gives a marked reaction, which would be very faint if due only to the power of the bisulphate to set boracic free from its compounds. I prefer to operate in the following manner, as the reactions are thereby given with greater distinctness.

The bisulphate is melted first into a bead on the platinum hook, and the substance under examination is added, but not in sufficient quantity to saturate all the bisulphate.

If a borate is present, the application of heat will give the characteristic green color to the flame, but rather faintly. If the flame is luminous, the green color may not be seen at all. If now a small quantity of fluor-spar is added to the bead, the boracic acid flame will be given with distinctness. A luminous flame interferes seriously with the observation of the peculiar green due to boracic acid. If the flame is non-luminous and is reduced to quite a small size, on putting the bead at the base of the flame, the green color will spread over its whole surface.

When salt of phosphorus is used to detect boracic acid instead of the bisulphate, the reactions are not so satisfactory, on account of the interference of the sodium flame with the observation of the green color due to boracic acid. A bead is first formed on the platinum wire from salt of phosphorus, and the substance suspected of containing a borate is added. If a borate is present, the quantity of boracic acid disengaged will not be sufficient to show a green color, but it will be noticed that the color due to sodium will become paler, as if partially neutralized by the color of the boracic acid flame. If now powdered fluor-spar is added to the bead, the sodium flame will become paler still, and the green color due to boracic acid will appear, although

not so brightly as with the bisulphate. If a small non-luminous flame is used and if the bead is held near the base of the flame, the green color may be seen quite distinctly, but if we use a luminous flame, the green color can be seen with difficulty and only in that portion of the flame immediately surrounding the bead.

The great increase of the green color after the addition of a fluoride to the bead makes it possible to use this reaction for the detection of hydrofluoric acid.

A bead should be formed first of bisulphate of potassa or meta-phosphate of soda and a small quantity of borax added, when a faint reation due to boracic acid will be given, as before mentioned. If now the substance under examination is added to the bead, there will be an increase of the green color due to boracic acid, if a fluoride is present.

In the case of cryolite, the increase in the green color is very difficult to observe on account of the brilliant sodium flame given by this mineral. but if the portion of the flame immediately around the bead be attentively observed, the increase of the green color may still be seen.

Brooklyn, August 7, 1874.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The twenty-third meeting of this Association, at Hartford, commenced August 12th, and adjourned August 19th, and was eminently a successful meeting.

The officers of the meeting were—

President. Dr. Joseph L. Le Conte, Philadelphia;

Vice-President, Prof. C. S. Lyman, New Haven;

Permanent Secretary, F. W. Putnam, Salem, Mass;

General Secretary, Dr. C. A. Hamlin, Bangor, Me.;

Treasurer, William S. Vaux, Philadelphia.

The Standing Committee consisted of ex-President, Prof. Joseph Lovering, of Cambridge, Mass.; ex-Vice-President, A. H. Worthen, of Springfield, Ill.; ex-General Secretary, Prof. A. C. White, of Brunswick, Me.; and the President, Vice-President, Permanent Secretary, General Secretary, and Treasurer of the Hartford meeting. The following members were added to the standing committee by vote: Profs. W. B. Rogers, E. W. Hilgard, G. F. Barker, B. A. Gould, Asa Gray, and E. S. Morse.

The officers of Section A were Prof. Simon Newcombe, of Washington, Chairman, and A. R. Leeds, of Hoboken, Permanent Secretary; Standing Committee, J. Lawrence Smith, J. H. C. Coffin, and H. Carrington Bolton. Of Section B, S. H. Scudder, of Boston, President; Dr. Theo. Gill, of Washington, Secretary; and Profs. S. F. Baird, E. T. Cox, and T. S. Hunt, Standing Committee.

A large meeting of members interested in chemistry was held, and conferred with a deputation of chemists named at the Northumberland Centennial.

After some discussion, a committee was named to confer with the Standing Committee of the Association, relative to the establishment of a permanent subsection of Chemistry, Chemical Physics and Technology, Metallurgy and Mineralogy. Dr. T. Sterry Hunt was in the Chair, and Prof. F. W. Clarke acted as Secretary.

The new Constitution was adopted at the final meeting of the Association; and we note with pleasure that there is to be a subsection of chemistry, A dividing into chemistry on the one side and mathematics and physics on the other. B separating into biology and geology.

The next meeting will be held in Detroit, commencing August 11th, with the following officers:—

President, Prof. J. E. Hilgard, Washington, D. C.;

Vice-President for Section A, Prof. H. A. Newton, New Haven;

Vice-President for Section B, Prof. J. W. Dawson, Montreal;

General Secretary, Prof. S. H. Scudder, Boston;

Permanent Secretary, for five years, F. W. Putnam, Salem, Mass.;

Treasurer, W. S. Vaux, Philadelphia;

Secretary of Section A, Prof. S. P. Langley, Pittsburgh;

Secretary of Section B, Prof. N. S. Shaler, Newport, Kentucky.

Prof. Asa Gray, chairman of committee to decide on the use of the $1000 fund presented by Mrs. Elizabeth Thompson, recommended to have engraved and printed the memoir of Prof. Scudder on Fossil Butterflies. The fund is for the promotion and publication of original investigations.

The preparation of obituary memoirs of deceased members was assigned as follows: Prof. Swallow, of St. Louis, to prepare memoir of the late Col. Foster; Prof. Thurber, of New York, of the late Prof. Torrey; Prof. Guyot, of Princeton, of the late Prof. Agassiz.

The following abstracts of papers of special interest to chemists are taken from the *Hartford Courant and Times* and the *N. Y. Daily Tribune*:—

The Sewage Question Chemically Considered.

By Prof. T. Sterry Hunt, of Boston.

Few questions are more important than this for our modern civilization from a sanitary point of view. Excrementitious matter poisons the soil and air of our towns, and contaminates all our water supply. In a densely populated country like England the importance of getting rid of such matters has been more urgently felt than among us, but already in our great centres it is forcing itself upon our attention, while many of our watering-places and seaside resorts, often with very inadequate drainage, are in danger of becoming seats of pestilence.

The pollution of waters by sewage is a serious evil. The plan to some extent employed in Great Britain of using sewage waters for irrigation is open to serious objections, and all the methods of purifying waters thus contaminated are confessed failures. The earth-closet system requires so much transportation of earth that it is impracticable in towns, while, unless great care is

taken, the disinfection is imperfect. It is estimated, however, that the economy effected by returning the fertilizing elements to the soil is in England eight shillings sterling per person per annum.

Besides the methods by water and earth, there is a third one—by fire. Attention has often been called to this purifying agent in connection with cremation, but a far more important source of danger is at hand. The new method attained in England is by substituting finely divided charcoal, obtained by charring seaweed, or street-sweepings. Only one-fourth as much charcoal is required as of earth. The odorless and partially dried mixture with this charcoal, after use, is removed from time to time and charred by heating to redness in close vessels like gas retorts, the products of the distillation being water, ammonia, acetic acid, tar, gas, and charcoal, the last being augmented in quantity, and ready for immediate use again, though containing alkalies, earth, and phosphates, which give it a great fertilizing power. From the product of the distillation the chief materials obtained are acetate of lime and sulphate of ammonia, the latter being the most valuable of fertilizers. The system was devised by Mr. Stanford, an English chemist. Tried for three or four years on a large scale at Dalmuir, near Glasgow, it presents no obstacles in practical operation, and the products obtained pay the cost of conducting it. Certainly so important a success deserves the attention of the American Association.

Prof. Johnson said that Stanford's method was the best solution hitherto attempted of the sewage problem. The difficulties in this country were greater than elsewhere. Liebig has said that the consumption of soap was a measure of civilization; the consumption of water is equally an important test, and here it is the greatest per capita of anywhere on the globe. The difficulties in countries where water is used for ablution in small quantities that could be evaporated on a chemist's spatula, are far less than here, where water runs from every faucet without let or hindrance. The question of sewage is one of the highest importance; the difficulties increase about it from year to year.

Prof. Chandler said that 104,000,000 gallons of Croton water were daily used in Manhattan Island—a quantity that could never be subjected to purification. The best thing that could be done in this case is to let it run into the rivers on both sides of the island. He was called upon for an opinion as to water supply for the city of Albany, N. Y. The Albanians had a prejudice against Hudson River water that had received the refuse of Troy, eight miles above. But Prof. Chandler recommended it. The simple action of dissolved oxygen soon dissolves (burns) the matter which contaminates rivers, and the Hudson River was pure by the time it reached Albany.

Prof. Hunt said that he had not proposed the system as a substitute for water sewage, but for earth-closets. Prof. Chandler said that night-soil, the most concentrated refuse material for fertilizing purposes, cost the city of New York $48.000 for its removal; no price could be got for it from contractors. Prof. Van der Weyde said that the Rhine water at its mouth, after passing numerous towns and cities, was pure and excellent. It was only when rivers were covered by ice that the impurity remained. Prof. Hough said that the water carried forty miles from the city of Chicago was still exceedingly impure, though the river ran over two dams. Prof. Van der Weyde could only suggest that Chicago must have an unusual power of making water dirty.

Mechanical Vibration Retarding Rust.

By Prof. S. S. Haldeman.

When railway bars are piled beside a road they soon become rusted, while those forming the track are but little subject to oxidation; and when a rain of some hours' duration falls upon rails in a state of rest, as upon Sundays, when trains do not run, they soon exhibit rust. This would seem to indicate that in chemical combination mechanical vibrations may interfere with the molecular arrangement of the elements. The accuracy of these casual observations should, however, be submitted to the test of experiment.

In the discussion which followed this brief communication it was suggested that possibly the oil employed upon locomotives might be more or less spread in a thin film over rails in use, and thus prevent their oxidation. This view was earnestly combated by other speakers. Prof. Van der Weyde was quite certain that the suggestion of Prof. Haldeman bore reference to a fact in physics. Molecular vibrations tended to prevent rust. A saw hung up, unused, would soon become rusty; if used, would keep bright. This was a general experience with tools.

On Wet Processes of Copper Extraction.

By Prof. T. Sterry Hunt.

Copper is generally got from its ores by smelting in furnaces, but for centuries it has been known that, by means of acids, it can be dissolved from its oxidized or calcined ores, and from the solutions thus obtained, thrown down by iron in a metallic state; a cheaper mode of making it soluble was sought, and by roasting the sulphurous ores with sea salt, it was found that the copper could be got as a soluble chloride. This process is largely used, and offers great advantages especially for ores holding a small percentage of copper; but the consumption of metallic iron in precipitating is considerable, and the amount of salt used and wasted is very large, being three tons or more for each ton of copper. The cost of salt in many copper-producing regions is very great, and the speaker described a new and more economical process contrived by himself and Mr. James Douglas, of Quebec, which is based on some little known reactions of copper and iron, which he had made known to the Association at a former meeting. When oxide of copper is brought in contact with protochloride of iron, this is decomposed, the iron being thrown down as peroxide, and the copper converted

into a mixture of one-third soluble protochloride and two-thirds of dichloride, insoluble in water, but soluble in a strong and hot brine. From this solution metallic iron throws down the whole of the copper or metal, regenerating the protochloride of iron, which is now ready to dissolve a fresh charge of oxide of copper, and so on indefinitely, using the same solution over again; the consumption of metallic iron being about two-thirds the weight of the iron. To prepare the ordinary sulphurous ores for this treatment it is only necessary to calcine them at a low red heat. In this process the injurious elements of the ore, such as arsenic, antimony, and tin, remain undissolved, and the metallic copper obtained is so pure that it can be made into fine copper by a single fusion. If, however, silver be present it is dissolved, and may be readily separated, so that this process is well adapted for silver-bearing copper ores, like many of those of the West.

The author described the works recently erected at the Ore Knob Mine, in North Carolina, where from 4000 to 5000 pounds of metallic copper are made daily by this process at a cost much below that at which it could be extracted by melting or any other process known, and stated that furnaces and tanks which will increase the production to four times that quantity are there in process of erection. Photographs of the present works and specimens of copper obtained in a beautifully crystallized form by this process were exhibited. The author then proceeded to notice briefly the copper deposits of Eastern North America which abound throughout the great Appalachian belt, from Newfoundland to Georgia. He had already called the attention of the Association, on a former occasion, to the importance of some of these in the Blue Ridge as sources both of copper and sulphur, which latter would be employed to treat the phosphates of South Carolina, and fit them for use as fertilizers, while the copper would become, he predicted, an important article of export from these regions at no distant day. He then alluded to the copper of the mesozoic or new red sandstone formation of this country, which contains an abundance of this metal, often disseminated in such a manner that the ores could not be advantageously smelted, though he conceived well fitted for treatment by a wet process like that just noticed. He had recently visited the deposits of this geological formation in Chester County, Penn., and described their mode of occurrence and geological significance and their economic importance. Similar deposits are known to exist in the new red sandstone of the Connecticut Valley, and deserved more attention than they had hitherto received.

Dr. Van der Weyde mentioned the use of tin scraps in a factory at Brooklyn, the tin being removed and the iron being converted into bars. He spoke of the process as not always successful. Prof. R. E. Rogers described a new method in use at San Francisco for separating silver and gold by the employment of protosulphate of iron.

A Direct Vision Spectroscope.

By Prof. R. E. Rogers, of the University of Pennsylvania.

This paper was entitled Notice of Prof. A. K. Eaton's new compound one-prism Spectroscope." The instrument is the invention of a well-known Brooklyn chemist, and is by himself named "a direct-vision spectroscope." It consists of a thick plate of glass with parallel sides, united to one of the faces of an ordinary bisulphide of carbon prism, or a prism of dense flint-glass. According to the amount of dispersion desired, the light is made to enter either on the end of the glass plate, or on the opposite face of the bisulphide prism. The results obtained from this instrument are as follows: The dispersion of this compound prism is nearly four times greater than that of the ordinary 60° prism. The mean emergent ray is practically parallel to the incident ray. It does not deflect the ray from its original path. Many Fraunhöfer lines are visible by this prism with the naked eye, while with the observing telescope all the prominent lines are clearly reversed, without the use of the slit or collimeter, by merely throwing a strong beam of light by means of a mirror.

When the usual appliances of slit-collimeter and telescope are employed, it widely resolves the D line and shows the nickel line between these two lines—a result claimed as the best obtained by a four-prism instrument of Browning.

It is stated (Prof. Rogers has not himself made the measurement), that a simple bisulphide prism in this instrument gives a dispersion of 40° between the B and G lines; when it is used for projection it gives a spectrum eight feet long at a distance of ten feet from the screen, enabling one hundred dark lines to be counted.

It is evident, therefore, that this prism promises to become a most valuable instrument for projection in the lecture-room, while either solar, electric, or oxyhydrogen illumination may be employed, having the great advantage of simplicity of adjustment, since it avoids the necessity of turning the lantern after the slit has been focused on the screen.

Prof. Perkins of Schenectady said that he had examined one of those instruments and was satisfied that all that was claimed for it was fully accomplished. Other members spoke of its admirable qualities. A discussion as to the possibility of seeing the Fraunhöfer lines without a slit involved a curious paradox. The lines, it is admitted, are the image of the slit. How then, Dr. Van der Weyde asked, could the images of the slit be seen when there was none. This was explained to general satisfaction by showing that in these case the beam of light was admitted at such an angle to the face of the crystal that it had only such width or thickness as to be equivalent to that which would pass through a slit, and thence gave a similar image.

The Nitrogen of the Soil.

By Prof. H. P. Armsby, of Millbury, Mass.

As the necessity of nitrogen to plant life is universally admitted, it has become an important problem in agricultural chemistry to ascertain the source whence plants derive their supply of that element. Lawes, Gilbert, and Pugh (*Phil. Trans.*, 1861) showed that the cereals, at least, are incapable of assimilating free nitrogen from the air; and this is probably true of all plants. It seems unlikely that the compounds of nitrogen—nitric and nitrous acids and ammonia—existing in the atmosphere, are assimilated, to any appreciable extent, from the air, under natural conditions. It has been abundantly proved, on the other hand, that a fertile soil is capable of supplying vegetation with all needful nitrogen, and we may conclude that it does so. The circumstances of the supply of nitrogen to the soil become therefore of the greatest importance to the agriculturist.

It is known that nitrogenous organic substances, such as are in freshly manured soils, may yield nitrogen in the free state by decomposition, though the particulars of this process are as yet imperfectly ascertained. It has been shown that under some circumstances organic bodies, such as exist in the soil, are capable of causing free nitrogen so to enter into combination with them as to increase their content of that element. This increase has been generally attributed to the formation of nitric acid from free nitrogen by some oxidizing action.

Muder raised bean plants in a soil free from nitrogen and with no nitrogen supplied except from the air. The crop contained two or three times as much nitrogen as the seed. The gain must have taken place through the medium of the soil. It has been shown by Will, (*Ann. Chem. Pharm.*, 45, 106) that this is not due to the formation of ammonia by the combination of nascent hydrogen and free nitrogen. Boussingault found that fertile garden soil, spread thinly in a glass dish and moistened daily for three months with water free from nitrogenous compounds, gained a small quantity of nitrogen and lost carbon. When lupines, hemp, and beans were raised in a soil protected from dews and rain, the absolute gain of nitrogen, both on the part of the soil and the plants, was demonstrated. In the case of an experiment on lupines, which was given in full detail, the gain appears partly as nitric acid and partly as ammonia, the former being the greater; but the total increase of nitrogen is much greater than that comprised in the sum of these two compounds. But in similar experiments where the soil was originally destitute of nitrogen, there was none accumulated. Cloez has, however, shown that a gain of nitrogen may take place in the absence of organic matter. In a later series of experiments Boussingault kept a rich vegetable soil mixed with sand in large glass vessels, sealed tightly for eleven years in a cellar. The amount of nitric acid increased over 200 fold, but the total amount of nitrogen decreased, vigorous nitrification having taken place at the expense of the organic matter of the soil.

Schönbein's theory that water during aerial evaporation united with nitrogen, forming nitrite of ammonia, was disproved by Zabelin, who showed that this compound was only produced in the presence of cellulose or some similar organic body. A series of experiments by Cloez on porous substances mixed with carbonated alkalies and long exposed to continual streams of purified air, confirmed these results; the exceptional cases being traceable to impure materials. The influence of humus in determining the fixation of nitrogen is further shown by the abundance of nitric acid in washed soil, as compared with the mere traces found in that which is ignited.

A third and probable theory explains the fixation of nitrogen by the soil by the supposition that, where it is contained in the interstices, it is converted into nitric acid by ozone developed by the slow oxidation of humus, or possibly by electrical disturbances. This process would accord with admitted properties of ozone. Gorup-Besanez showed that ozone was formed during the evaporation of water in contact with organic matter. The condensation of nitrogen and oxygen in the pores of humus, proved by Reichardt and Blumtritt, would favor this reaction. Experiments of Lawes, Gilbert, and Pugh (*Phil. Trans.*, 1861) do not impugn this theory, though showing that organic matter must pass into the comparatively stable condition of humus before ozone with it can produce nitrification. Deherain has recently shown that the amount of nitrogen fixed by organic bodies is more than sufficient to have formed nitric or nitrous acid with all the oxygen present. Many details of these experiments, which were numerous and varied, were adduced. The escape of free nitrogen from decomposing animal substances has been fully determined by experiments of Reiset, Lawes, Gilbert, and Pugh. There are substantial reasons for the belief that this results from the oxidation of amide-like bodies in which, the hydrogen being oxidized, the nitrogen is set free. Schloesing showed that this reaction could be brought about by the oxidizing effect of nitrate of potash. König and Kiesow demonstrated that the escape of nitrogen could be prevented by the addition of gypsum.

The author of the paper made a series of experiments to throw light upon the loss and gain of nitrogen; the method adopted being to allow organic matter containing a known amount of nitrogen, to decay under circumstances in which all the nitrogen given off or accumulated could be measured. The organic matter consisted of dried and sifted barnyard manure mixed with one-quarter its weight of dried and pulverized flesh. The experiments marked I were conducted in purified air; those marked II, in purified nitrogen. The mixtures were moist but not coherent. Various details to obtain purity and accuracy received due attention. The exposure to air in the first set of experi-

ments was kept up for more than two months; the exposure to nitrogen was for a shorter period. The temperature varied from 50° to 80°, averaging 70° Fahr. The apparatus was exposed to diffused daylight, but not to direct sunshine.

QUANTITIES AND MATERIALS USED.

No. of experiment.	Organic matter: grms.	Gypsum: grms.	Potash (KOH): grms.	Water: c.c.	Total nitrogen: grms.
I. 1	15	..	....	6	0·486
I. 2	15	..	0·798	6	0·486
I. 3	15	15	....	6	0·486
I. 4	15	15	0·798	6	0·486
II. 1	15	..	....	6	0·453
II. 2	15	..	0·798	6	0·453
II. 3	15	15	....	6	0·453
II. 4	15	15	0·798	6	0·453

NITROGEN AFTER DECOMPOSITION (IN GRAMMES).

No. of experim't.	Substances.	Gain of ammonia expressed as nitrogen.	Total gain of nitrogen		Total loss of nitrogen.	
			Wt.	Pr. ct.	Wt.	Pr. ct.
I. 1	Organic matter	0·0118	....	....	0·054	11·11
I. 2	Organic matter and potash	0·0301	0·074	15·22	....	....
I. 3	Organic matter and gypsum	0·1651	....	....	0·0302	6·21
I. 4	Organic matter, potash, and gypsum	0·0907	....	....	0·0636	13·09
II. 1	Organic matter	0·0614	0·0067	1·48	....	....
II. 2	Organic matter and potash	0·0255	0·0876	19·34	....	....
II. 3	Organic matter and gypsum	0·0784	....	....	0·0052	1·14
II. 4	Organic matter, potash, and gypsum	0·0479	....	....	0·0088	1·94

These results show a loss of nitrogen in all cases except I 2 and II 2; the small gain of II 1 being within the errors of experiment. The loss is very much less in the second than in the first series of experiments. This cannot be attributed to shorter duration, since the gain of II 2 is greater than that of I 2. It confirms the deductions of Lawes, Gilbert, and Pugh, that the loss of nitrogen is caused by a process of oxidation. Gypsum seems to prevent in part the loss of nitrogen. The relation of the formation of ammonia to the experiments is not obvious. A considerable gain of nitrogen is effected in the experiments where potash alone is mixed with organic matter. No trace of nitric acid was found, and there is no reason to suppose it was formed during the experiments. The gain of nitrogen cannot be ascribed to nitrification. The fact of the fixation of nitrogen is demonstrated; the method is as yet open to question. The following conclusions sum up our present knowledge: 1. The loss of free nitrogen during the decomposition of nitrogenous organic matter is generally due to oxidizing action. 2. An increase of combined nitrogen in soil may take place by oxidation of free nitrogen to nitric acid. 3. Some organic substances in the presence of caustic alkali are able to fix free nitrogen without the agency of oxygen or the formation of nitric acid.

Prof. Van der Weyde stated that the experiments of Prof. Viele at Paris in the later part of the late empire were similar to those of Prof. Armsby. He made a perfectly artificial soil and an artificial air for the cultivation of plants. He proved that the cereals did not take and could not take the nitrogen from the air, but leguminous plants can and do. The experiments were very extensive and conclusive.

Prof. A. P. S. Stuart of Champaign, Ill., said that the experiments of Prof. Journelle showed that plants absorbed nitrogen converted into nitrous acid in the soil. Pure sand did not produce nitrous acid, but with the addition of carbonate of lime the acid was formed, the product being a nitrate of lime. With carbonate of baryta or of strontia Prof. Stuart accomplished the same result. Prof. E. W. Hilgard made the point that soils must contain clay; without it they were not soil. This clay contains animal matter—the germs of the green spawn and of fresh-water algæ. This is the case throughout the world. The peat bogs are a product of such growth. These germs are among the smallest that exist. They are always ready to start into life, and to start decomposition. Prof. Hilgard claimed priority of discovery in respect to these algæ. Prof. S. T. Hilgard confirmed the observations of his brother, and stated that at the South the transformation of soil by such vegetation is very rapid and evident. Prof. Van der Weyde remarked on the importance of investigating the part which nitrogen takes in animal life to which it is essential. The negative qualities of that element cause it frequently to elude our grasp. Prof. S. W. Johnson of Yale College said that we were as yet very ignorant on this whole subject. Nothing is really yet known as to the mode in which plants obtained nitrogen. These experiments, more carefully and accurately conducted, will throw great doubt over the nitrous acid theory. He deprecated conclusions from such slender premises. The chemical test usually employed is open to question. But Prof. Johnson regarded the experiments of Prof. Armsby as of great value as showing a direction in which to push these investigations with fair hope of success.

A JET ASPIRATOR.

By Prof. Robert H. Richards.

During the Winter of 1868–9, while assistant in the chemical laboratory of the Massachusetts Institute of Technology, Prof. Richards was called upon to put up Bunsen's filter pumps for the chemical laboratories. While studying the best form of the instrument, it was noticed that this aspirator did not utilize in any way the water pressure derived from the hydrant. The instrument here described is the result of an attempt to produce an aspirator which should make use of the hydrant pressure. The principle is somewhat the same as that of the Giffard injector, the jet pump, and the steam siphon. But as all of these instruments derive their power from steam, and have for their object the movement of water, it became necessary to investigate anew, by a set of careful experiments, the best form

and conditions when the aspirator instrument was called upon to do the work of an air-pump with a water pressure as its source of power. A discussion of the sizes of jets, the various amounts of water pressure needed under particular conditions, the form of the cone of the enlargement, the angle of this cone, etc., cannot well be understood without having at hand the appropriate diagrams, but the results can be stated in a few words. An aspirator of this form produced its vacuum in a quart vessel in ten minutes (one litre in eleven minutes).

This same aspirator, when pulling against half a vacuum, more properly when sustaining one-half the atmospheric pressure, is able to carry forward a volume of air equal to one-half the volume of water used as its power. The diameter of the jet may vary relatively to the diameter of the apex of the cone into which the water is projected, and the result of this variation is as follows: The smaller the jet, the less will be the amount of water required to carry forward a given amount of air, and the less will be the power of the instrument to produce a vacuum; while, on the other hand, the larger the water jet the greater will be the amount of water used and the greater will be the vacuum producing power of the aspirator.

But the moment the water-jet becomes larger than the cone apex, the instrument is paralyzed and useless. The aspirators which were experimented upon yielded a rarefaction (after making the correction for aqueous vapor) within one and one-half to two millimeters of the Torricellian vacuum within the barometer by its side.

Prof. R. E. Rogers, of the University of Pennsylvania, supplemented this paper by a description of a very interesting apparatus which he devised many years ago, and has been using in connection with a high-pressure steam-engine. By means of an aspirator of a peculiar construction, placed between the boiler and the steam-chest, the steam is made to draw, at each stroke of the piston, a volume of air into the engine. By this admixture the power of the engine is materially increased. The ratio of augmentation depends on the relation between the size of the cylinder and the work to be done, showing, in a large number of experiments, an actual gain ranging from 20 to 30 per cent. over what would be accomplished by the ordinary engine working steam alone.

The explanation of this is to be sought by a reference chiefly to the following facts: 1. Condensation of the steam into water, which ordinarily takes place in the cylinder, is in a great degree prevented, and thus its efficiency maintained. 2. Whatever steam may be condensed by mixture with the air imparts its latent heat to the air, thereby giving it elastic power. The same is true of the effect of the hot water of condensation. 3. The difference of specific heat of steam and air is such as to make the gain of expansive force by the air greater than the loss sustained by the steam.

On the Molecular Volume of Water of Crystallization.

By Prof. F. W. Clarke, of the University of Cincinnati.

Prof. Clarke stated that, to the chemist, it is important to get at some distinguishing character between water of crystallization and true water of hydration. This character may be found by a study of the molecular volumes of various hydrated compounds. If we determine the molecular volume of frozen water, that is ice, we shall find it to be 19·6. If that water unites to form a hydrate or a crystalline salt, contraction ensues, and by studying that contraction we get at curious results. In the case of water of crystallization, Prof. Clarke has studied over 30 salts, and in every case the molecular volume of the water is about 14. With water of hydration no such regularity is found. Evidently, then, when water unites with an anhydrous salt from water of crystallization, all the condensation which occurs is on the part of the water, the volume of the molecule of the salt itself remaining unchanged.

On the Molecular Heat of Similar Compounds.

By Prof. F. W. Clarke.

Prof. Clarke said that it is commonly thought that similar compounds have equal molecular heat. This is only approximately true. In comparing about twenty series of similar compounds, Prof. Clarke finds that the molecular heat increases slightly with the molecular weight, though in a very different ratio. In comparing all the extant determinations of specific heat, he has found only two or three exceptions to this rule, and even they were doubtful.

Prof. G. F. Barker said: The bearing of this subject on mineralogy is exceedingly important. The possibility of classifying by this means the relative position of the water atoms in salts is thereby indicated, and it is certainly very desirable to determine these points. We all know the difficulty of determining the relative amounts of water of crystallization and of hydration. This paper points the way to a solution of the problem. Prof. Johnson expressed his deep interest in Prof. Clarke's paper, and thought that the suggestions conveyed as to molecular constitution were of the highest value. Prof. Leeds mentioned the value of the tabulated series of constants which have recently been issued by the Smithsonian—the work of Prof. Clarke. Prof. J. L. Smith said the want of such tables is partly due to the fear of publishing inaccurate results. The delicacy of the instrumental investigation required is almost inconceivable.

Prof. T. Sterry Hunt expressed a belief that there was a connection between the specific gravities and the atomic weights of the elements. He instanced approximate experiments which indicated some such relation. Prof. Langley, of Pittsburgh, asked whether it was to be considered that chemical equivalents are variable quantities. Prof. Hunt disclaimed such a position.

Prof. Barker said that we cannot conceive of atomic heat. The question at issue was one exactly intermediate between chemistry and physics. We need laboratories where chemical physics can be taught. We need to know, to ascertain, these constants which Prof. Clarke has tabulated. The chemist can furnish substances in a state of purity, but he too often fails to carry out the class of investigations on the border line between chemistry and physics. Here is the great field for work and discovery.

Exhibition of a Platinum Digestor.

By Prof. H. Carmichael.

The author exhibited a new platinum disgestor, by means of which minerals and other matters insoluble in acids at ordinary temperature may be digested and disintegrated at high temperature by means of acids under pressure. Within a box of cast-iron is placed a capsule of platinum, above which, when in use, a ring of asbestos paper is placed, and above it a cover of cast-iron. In the bottom of the apparatus is inserted a regulator for adjusting the degrees of temperature of heat to be applied. A stopcock in the side of the digestor admits of liquids or vapors being blown off. The instrument shown had been in use for a year, and the cast-iron cover of it was entirely free from corrosion.

Datholite, Garnet, and Idocrase.

Prof. J. Lawrence Smith, of Louisville, Ky., read a brief paper on a specimen of rock obtained by him from Santa Clara, California, which contained calcareous spar, datholite, garnet, and idocrase. He said he knew of no other locality where specimens of the various minerals were found combined just in the manner as in the specimen referred to.

The special interest was in connection with the penetration of the crystals of garnet by fibrous crystals of idocrase, the idocrase penetrating in such a manner as to lose itself as it were in the garnet—the first observation of the kind that has been thus far noticed.

Absolute Alcohol.

Prof. Smith also addressed the sub-section of the association on the subject of "A convenient method of making absolute alcohol." To a pint of 94 or 95 per cent. alcohol he uses 2 oz. of caustic lime, from which he gets an alcohol of 98 per cent. By redistillation he gets a still purer alcohol.

The Chemistry of Steel.

By B. S. Hedrick.

Professor Baur of New York found that chromium was a steel-making element, acting like carbon. It was formerly supposed that silicon must be entirely burned out of the iron in the manufacture of steel. It is now found that silicon is also a steel-making element when made to take the place of carbon. Professor Du Motay of France has lately shown that phosphorus is a steel maker. Boron and aluminium can be put in the same list. Thus substances, which have heretofore been regarded as highly injurious, can be used in the manufacture of true steel if the carbon is removed and the proper quantity of the other be substituted. Discussed by Professors Smith, Hunt, Silliman, and Johnson. Professor Smith gave his experience with reference to cast-iron containing phosphorus as better resisting the effects of strong acids. Professor Hunt stated that wrought-iron having as high as one per cent. of phosphorus shows a remarkable power in resisting friction, as in sleigh runners, instancing the use of this iron from a noted foundry in Canada. Professor Johnson remarked that titanic iron ore found in the Adirondacks is wonderfully free from phosphorus, sulphur, and other impurities, although the manufactured iron contains no trace of titanium, and the process of reducing the ore is too expensive for the profitable working of these mines.

On Lithium Glass.

By Chas. B. Dudley.

The alkaline nature of lithium was evident, from the very discovery of the element. It occurred to the author by the experiment of making a glass with lithium, and of determining its properties. It was thought best to make the experiment with the most fusible materials; and the attempt was made to obtain a silicate of lead and lithium. The silica was obtained from common quartz crystals, pulverized and treated with hydrochloric acid. The lead was commercial red-lead. The lithium was a carbonate precipitated by carbonate of ammonia, from crude chloride. Eight fusions were made; and no attempt was made to fuse more than 25 grains at once. There were many difficulties in the operation of the experiment, as from the presence of iron, the small quantity of materials employed, and the lack of conveniences in the laboratory. But three pieces of glass were obtained large enough to work with. The glass is clear, quite hard, somewhat tinged with green, probably on account of the presence of iron. Its specific gravity is from 3·3 to 3·6; its index of refraction is 1·60; its dispersive power was not satisfactorily determined.

On the Use of a Glazed Wrought-Iron Tube for Nitrogen Determination.

By A. P. S. Stuart.

It was stated that an unglazed wrought-iron tube, when deprived of air and heated, allows hydrogen gas to pass through its pores, but when externally glazed and heated, such a tube becomes perfectly impervious to gases. Such a tube was, therefore, for obvious reasons, well suited for making nitrogen determinations, and experiments, so far as they have been made, promise excellent results. During the experiments made by the writer on this subject, his attention was called to an inference of Professor Graham, on the origin of hydrogen in meteoric iron, and the suggestion was made that possibly such hydrogen did not come from the celestial spaces, but from water decomposed by the hot iron when it was buried in the earth.

On the Cement of Ransome's New Artificial Stone.

By Dr. T. Sterry Hunt.

The author discussed the character of the natural cements of sandstones, and explained the well-known use of silicate of lime formed by soluble glass and chloride of calcium to cement sand into artificial stone. From this the chloride of sodium formed by the reaction is removed by washing. But Ransome has lately found that the use of silicate of soda with quicklime and a portion of soluble silica produces a cement in which the soda, rendered insoluble and as a double silicate of lime and soda, produces a cement of great value for the manufacture of artifical stone.

Carbonates of Soda and Potash.

Prof. J. Lawrence Smith made a statement as to the best methods of making pure carbonate of soda and carbonate of potash for analysis. The first he prepares from the oxalate of soda, the second from the nitrate of potash.

On the Thermo-electrical Properties of some Minerals and their Varieties.

By A. Schrauf and E. S. Dana.

The interesting investigations of Rose, the late eminent mineralogist of Berlin, have during the past two or three years excited considerable interest in this subject. Rose started with the fact first announced by Hankel, that some crystals of pyrite and cobaltite are electrically positive, and others negative, and endeavored to explain the opposite character on the assumption that it was connected with and conditioned by the right and left hemihedrism, characteristic of both species. This touches an important point in physics, and, if it could be sustained, Rose's hypothesis would be very valuable. Schrauf and Dana, however, after the examination of a large number of minerals, comprising nearly all the metallic sulphides, have come to the conclusion that the cause of the variation of electrical character must be sought elsewhere. They attribute it, not to an opposite molecular condition shown in hemihedral crystals, but to a change in chemical composition.

They call attention in the first place to the series published by Lubeck, where for example platinum occupies a varying position according to its degree of purity. Moreover, they urge that the single case, observed by Stefan, that some specimens of granular galena are positive, while others of crystallized galena are negative is strong evidence against the influence of hemihedrism in general, as nothing of the kind can be assumed here. The force of their argument, however, lies in the fact that they have found several other well-defined cases of minerals, having varieties, and that among minerals crystallizing holohedrally. Chemical analyses were here desirable to show how far the material under investigation varied in composition. In the absence of these, the specific gravity was resorted to as an indicator of the chemical character. This afforded decisive results; the plus and minus varieties showed a decided difference in density, implying a corresponding change in composition. This was true in all cases investigated, including cobaltite and pyrite, showing where the explanation of the electrical character was to be looked for.

On the Growth of Crystallization in Traps and Slags.

By Dr. Carmichael.

He stated that in 1820 Worcester found in diamonds and chryso-beryls a fluid and in some cases two fluids having an expansive capacity thirty-two times that of water. Examined microscopically these liquids and also glass were found to exist in the minute cavities of various rocks. Dr. C. stated that he himself had made many examinations of slags from the Hartz mountains. These crystals were no doubt formed with great rapidity, and this fact in part accounted for the finding of aqueous solutions in the centre or cavities of crystals. Bubbles of air also might, while the crystals were being formed, produce irritation and lead to the deposits of glass found in the inclosure of the centre of crystals and slags. In the genuine trap-rocks liquid [carbonic acid] inclosures are found, sometimes with minute traces of watery vapor. Gas cavities have broad margins, the vaporous cavities thin margins. There is a law of symmetry in this formation or growth of crystals which Dr. Carmichael thinks has not been sufficiently dwelt upon; and he produced various diagrams on the black-board to illustrate his idea.

Change of Peat into Coal.

Prof. Vander Weyde made a brief statement respecting the change of peat into cannel or other coal by heat and pressure. In his own country, Holland, he said peat was extensively used; but the great difficulty had been in freeing it from moisture. At some point on the Hudson River, in the State of New York, hydraulic pressure had been applied in the preparation of peat, and it was possible to make it so dense that it should become as hard as coal, and even capable of taking on a high polish. In Holland peat is prepared in blocks of about double the size of common bricks. He believed peat would yet become exceedingly valuable as an article of fuel.

On the Mineral Warwickite. By Dr. J. Lawrence Smith.

On Metal Iron in Basaltic rock and the dissociation of Oxide of Iron. By Dr. J. Lawrence Smith.

Exhibition of a new Sulphuretted Hydrogen Apparatus. By H. Carmichael.

On a Modification of Loewenthal's Method for the Estimation of Tannic Acid. By Prof. Wm. McMurtrie.

Report on a Remarkable Compound of Phosphorus and Carbon, forming a new Pyrophorus. By P. H. Vander Weyde.

Investigation of the Chemical Nature of Petroleum. By P. H. Vander Weyde.

The following papers, by Professor Johnson of Yale, were read by title:—

On the Estimation of Nitrogen by the Absolute Method. On the Estimation of Nitric Acid by the Methods of Thorpe and Bunsen. On the Alleged Formation of Ammonium Nitrite from Water-vapor and Nitrogen, and on Price's Test.

The following papers, by Professor Wright of Yale College:—

On the Phosphorescence of Glass, produced by electricity. On the use of Natural Twin Crystals of Quartz in the Construction of Polariscopes. On the nature of the Zodiacal Light, and the distribution of the matter which occasions it.

Professor S. W. Johnson was chosen the permanent chairman of the subsection of chemistry for the coming year, and Professor F. W. Clarke a committee of one to make arrangements for the organization of this subsection when it shall meet in Detroit next year.

STUDY OF THE PRODUCTS FORMED BY THE ACTION OF HYDROCHLORIC ACID ON CAST-IRON AND STEEL.

BY S. CLOËZ.

Translated by Chas. A. Pitkin, B.A.

Near the close of the last century the learned French chemist Proust noticed that the combustible gas produced by the action of sulphuric or hydrochloric acid on some forms of cast-iron and steel is accompanied by a sort of essential oil, which condenses in little drops on the sides of the vessel in which the reaction takes place, and in the parts of the apparatus, tubes, or receivers in contact with the gas. According to Proust, the oily product thus formed is not all carried away by the hydrogen gas, but a considerable portion of it remains in the black carbonaceous residue left by the action of the acid on the cast-iron. To extract this part it is only necessary to macerate the residue in alcohol, filter, and add water to the filtrate. The mixture grows white, and the oily matter completely separates out.

Many chemists have confirmed the accuracy of the facts observed by Proust, but the nature of the products which he obtained is not yet thoroughly understood. M. Hahn has done some interesting work on this subject, but many points remain to be elucidated or verified.

The researches of which I have the honor to submit the first results to the Academy will comprehend the whole subject, but I must confine myself at the present time to explaining the course which I have followed, and pointing out certain new facts, which I have been able to observe. I have used in my experiments a beautiful brilliant cast-iron, containing manganese, with large crystalline faces (Spiegel Eisen) containing about four per cent. of combined carbon, six per cent. of manganese, a small quantity of silicon, and traces of phosphorus and sulphur. This iron reduced to small fragments was treated with hydrochloric acid diluted with twice its volume of water. The action of the acid in the cold on the white cast-iron was very feeble. To increase it, I placed the vessel containing it in a water-bath, with a temperature of 75° to 90°. The disengagement of gas was then continuous, and I succeeded in dissolving in a single apparatus about 600 grammes of iron per day.

The gas, as it was formed, passed successively into two tubulated flasks containing cold water. It next passed down into a receiver filled with pieces of pumice stone saturated with sulphate of copper, and then into a bitubulated flask, where it came in contact with bromine covered with a layer of water. The apparatus thus arranged enabled me to collect—

1st. The oily liquid condensed in the first two receivers. This was the liquid obtained by Proust. The quantity produced in my experiments amounted to about one per cent. of the weight of iron taken.

2d. The bromine products resulting from the absorption of gaseous hydrocarbons (C_nH_n), by the bromine.

3d. The solid and liquid products which were obtained by treating the insoluble carbonaceous residue of the cast-iron with carbon disulphide and with alcohol.

The oily liquid obtained directly by condensation is lighter than water, colorless, and very mobile. Subjected to distillation, after it had been in contact for two days with fused chloride of calcium, it commenced to boil in the neighborhood of 120°. About a third of the liquid passed over below 140°, a smaller quantity between 145° and 160°, and for the rest the temperature rose gradually up to 200°.

I then endeavored to obtain by the method of fractional distillation a pure product with the most volatile part of the liquid.

This process, though simple when one has a sufficient quantity of the liquid product, is very difficult and laborious with only twenty or thirty grammes.

I succeeded, nevertheless, in thus separating a hydrocarbon, which completely distils between 118° and 124°, and has the composition and properties of caprylene or octylene $C_{16}H_{16}$.

Note.—It will be noticed that here, as well as elsewhere in the translation, the symbols of the original are adhered to.

The ultimate analysis gave the following figures for the percentage composition of this liquid:—

Carbon	84·92
Hydrogen	14·17
	99·09

By subjecting to distillation the mixture of bromine products obtained with the conditions indicated, I found that the liquid commenced to boil at about 130°. The temperature rose rapidly to 140° or 145°, where it remained stationary quite a long time. It then rose gradually to 160° where it again stopped, and finally rose very slowly to 190°. At this point hydrobromic acid was formed, arising from the decomposition of the very condensed bromine compounds. It seemed best not to carry the distillation too far, but to set aside the less volatile portion which did not distil over, and treat it with an alcoholic solution of potash, in order to change the hydrocarbons which it contained into products more stable and of a simpler composition.

By setting aside the first, and, therefore, most volatile products of this distillation, I expected to obtain ethylene dibromide, $C_4H_4Br_2$, which is easily recognized by the rapidity with which it solidifies at a temperature near 0°.

But not only did this solidification fail to take place at its normal temperature, but the product under examination remained liquid after being exposed for four hours to a freezing mixture at a temperature of —18°.

The determination of the specific gravity of the liquid

confirmed this fact indicated first by experimental observation. That of the most volatile product which distilled at 135° was found to be 1·782 at 15°; while that of pure ethylene dibromide examined under the same conditions was found to be 2·170.

The results of the ultimate analysis show that the difference observed in physical characteristics extends as well to the composition. I found in 100 parts of the product examined the following proportions, which approach more nearly to the composition of propylene dibromide than that of the corresponding ethylene compound:—

	Volatile bromine product from cast-iron.	Ethylene dibromide.	Propylene dibromide.
Carbon	19·33	12·76	17·82
Hydrogen	3·40	2·13	2·97
Bromine	79·13	85·11	79·21
	101·86	100·00	100·00

Treatment with an alcoholic solution of potash, of the bromine compounds which are decomposed by heat, enabled me to discover in these products the presence of heptylene bromide, $C_{14}H_{13}Br$, which boils at about 130°, and of the next higher product in the series, caprylene or octylene bromide, $C_{16}H_{15}Br$, distilled at 150°.

The first gave by analysis—

49·53 per cent. Br.
Calculated 49·08 " " "

And the second by analysis—

45·68 per cent. Br.
Calculated 45·20 " " "

Besides the oily liquid product which condensed in the first washing flask, through which passed the mixture of combustible gas, and hydrocarbon vapors resulting from the action of the hydrochloric acid on the white cast-steel, there was deposited on the sides of this flask a perfectly crystallized product, which volatilized without decomposition, but of which I failed to obtain a quantity sufficient to study its properties, and make an ultimate analysis. As the process will continue several months longer, till the 150 kilogrammes of cast-iron that I propose to treat is all dissolved, I hope to obtain at least enough of this curious product to guide me in the study of it.

Before treating, as I did at this time, white cast-iron containing manganese, I had tried the action of hydrochloric acid on ordinary gray cast-iron under the same conditions. 50 kilogrammes of gray cast-iron under this treatment gave no oily hydrocarbon. As to the amount of bromine products obtained it was very small, not so much as one thousandth part of the weight of the cast-iron. It is worthy of remark that so slight a yield represents but a very small fraction of the combined carbon in gray cast-iron.—*Comptes Rendus.*

RESEARCHES ON FOREIGN BITTER SUBSTANCES IN BEER.

BY W. KUBICKI.

Translated by Elwyn Waller, E.M.

Professor Dragendorff, of Dorpat, has sought a method for detecting alkaloids or other toxical and bitter substances which are introduced into beer. This method depends on the principle, determined by experiments, that, when the solution to be examined is agitated with petroleum, ether, benzine, and chloroform, the substances in question, when they have been used, are given up as well by the acid solutions as by those which are alkaline, when these solvents are evaporated so as to give a residue.

This method has been applied by Prof. Dragendorff in the examination for the bitter substances usually employed, and also for substances which are not alkaloids, as picric acid, salicine, colocynthine, picrotoxine, and capsicine; also for the following alkaloids: strychnine, atropine, hyoscyamine, and the opium alkaloids sometimes used to falsify beer.

Mr. W. Kubicki has also, on his part, applied this method, and in a memoir inserted in the *Journal de Pharmacie pour Russie*, August, 1873, has given an account of his labors, of which, considering its length, we can only give an extract.

Mr. Kubicki's researches had for their object the detection of the following substances in beer by this method: *quassia cetraria* (quassia), *absinthium* (absinthe), *trifolium fibrinum* (menyanthes trifoliata), *ledum palustre* (marsh tea), *cricus benedictus* (blessed thistle), aloes, *cetraria Islandica* (Iceland moss),* *erythrea centaurium* (red centaury), *daphne mezereum* (yarrow), *gentiana* (gentian), and he has also extended his researches to the alkaloids of colocynth and the Levant wormseed.

First of all it was necessary to make certain of the reactions afforded by the pure extracts of malt and hops, as well as those of pure beer with and without hops. As it appears to be established that the fermentation has no effect, and that the addition of hops only affects the flavor, the experiments were all made on extracts and preparations made expressly for the purpose.

In the examination of a hop beer, the author depended upon the works of Mr. Enders and Mr. Lermer, at least so far as they treated of the bitter principle of the hop. The latter was of but little use to him, because no reactions are given, and the crystalline form there described as characteristic, in consequence of the large quantity used by Mr. Lermer, and the vagueness of his method, could not be distinguished by the author.

The bitter principle of the hop is described by Mr. Enders as amorphous, easily soluble in alcohol, ether, chloroform, and slightly soluble in water. The aqueous solution is precipitated by plumbic subacetate, but not by tannic acid, ferric chloride, or mercuric chloride. It does not reduce an ammoniacal solution of argentic nitrate. It dissolves in concentrated sulphuric acid, turns brown, and precipitates in gray flocks when the solution is diluted.

The bitter principle obtained by Mr. Lermer has the following properties: It crystallizes in prisms, with a pure bitter flavor, hot and agreeable; it dissolves readily in alcohol, ether, chloroform, and in water to so slight an extent that it can scarcely be detected by the taste; but this flavor is strongly produced when the crystals are first dissolved in alcohol, and water is then added.

According to Mr. Leuchs, the hop bitter is decomposed by various substances, among others by sulphurous acid and its salts, by aldehyde, and also by formic acid and its salts.

The researches of Mr. Kubicki on a pure beer as well as on a fermented and a non-fermented extract of malt, gave the following results:—

I. A. *In acid solution.*—Petroleum ether extracted but little; the residue from the evaporation of the solu-

* This substance has but little importance as a bitter, but as it gives a certain consistency to the beer, and makes it more frothy, it is often added to this beverage in the northern countries.

tion when separated is small, amorphous, grayish-yellow; that from beer made with hops is a little more bitter than that without hops, with a taste and odor reminding one in general of amylic alcohol. Nitric and sulphuric acids give nothing characteristic.

The residue from the agitation with benzine is better characterized than the preceding; it is yellow, almost completely soluble in ether; that with hops is very bitter compared with that which contains no hops. Sulphuric acid, sulphurous, hydrochloric, sulphomolybdic (Fröhde's reagent), and sulphonitric acids, bromine water, tannic acid, potash ley, potassio-mercurous iodide (Nessler's reagent), and tincture of iodine are without very marked action upon it.

The residue from the action of chloroform is much more considerable than the preceding, dark yellow, with a slightly bitter taste, and almost the same for that made with or without hops. Concentrated sulphuric, sulphomolybdic, picric, and phosphomolybdic acids are indifferent to it. With tannic acid, the insoluble portion gives in ether a white precipitate, but none in the portion soluble in ether; the ammoniacal solution of silver is reduced, while that passing into solution in benzine does not give this effect. The author has therefore thought that two different bitter substances exist in the hop, of which the one dissolves in chloroform, and the other in benzine; the former possessing the properties remarked by Mr. Enders, while the other acts differently with the ammoniacal solution of silver and tannic acid.

B. *In alkaline solution.*—Petroleum ether extracted almost nothing; the other tests with the reagents were negative.

The residue from benzine was small, gray, a little more bitter with hops. Tincture of iodine, phosphomolybdic acid, and Nessler's reagent gave a slight turbidity, coming perhaps from the alkaloid discovered by Mr. Lermer in beer. With regard to this alkaloid, Mr. Kubicki has found that it neither shares in nor interferes with the ordinary reactions, serving to determine the identity of strychnine, atropine (daturine), or hyoscyamine.

The residue from agitation with chloroform is a little larger than that from benzine; is yellow, scarcely bitter, and afforded no reaction with picric and phosphomolybdic acids. All the residues, as well those from the acid as the alkaline solutions, were not crystalline. The substance obtained by chloroform in acid solution remained amorphous, even after treatment with ether or alcohol.

In reviewing the preceding facts, we see that, with the exception of the reduction of the ammoniacal silver solution by the acid product from agitation with chloroform, the precipitation of the portion from this product insoluble in ether, by tannic acid, and the alkaloid reaction in the residue coming from the agitation with benzine in alkaline solution, the solutions from the agitation of malt or beer do not give any result which might cause error in the proximate analysis for other bitter substances than hops in beer.

II. The examination for bitter substances when mixed with beer, in pure aqueous extracts, was the object of the second portion of Mr. Kubicki's work. The quantities of these bitter substances cannot, in consequence of their flavor, be arbitrary; they must not give the beer a repulsive taste, or properties foreign to those of good ordinary beer. The examination should therefore only be carried to the detection of small quantities, and was undertaken in the following manner: 10 grammes of each substance, and 2 grammes of aloes were weighed out; some, as cassia, were boiled in 2 litres of spring-water, the others extracted by boiling water. The filtered liquor for each amounted to one litre.

Mr. Kubicki then proceeded to examine the reactions which characterized each of the bitter substances previously indicated, and to render the results obtained by Prof. Dragendorff and himself more tangible, he has made up the following table:—

A.—Agitation in Acid Solution.

I. *Residue of Petroleum Ether.*

1. Crystalline, yellowish, slightly volatile. The solution remains yellow; potassic cyanide and caustic potash color it red; on heating, cotton is dyed yellow. *Picric acid.*
2. Amorphous, white, sharp taste, and reddening the skin. *Capsicine.*

II. *Benzine Residue.*

1. Crystalline.
   - *a.* Not bitter, and becoming purple with caustic potassa. *Alvetine.*
   - *b.* Bitter, becoming yellow with caustic potash, and brown on heating. *Daphnine.*
2. Amorphous.
   - *a.* Sulphuric acid colors it brownish-red, tannic acid precipitates. *Quassine.*
   - *b.* Heated with dilute sulphuric acid, odor of menyanthole, with clouding of the solution, and elimination of oily drops. *Menyanthine.*
   - *c.* Sulphuric acid colors it blood-red, afterwards brown-red, hydrochloric acid greenish; after heating brown, cloudiness and elimination of oily drops. *Cnicine.*
   - *d.* Sulphuric acid colors it brown, afterwards blue-violet; same with sulphomolybdic acid. *Absinthine.*
   - *e.* Sulphuric acid colors it dark red, sulphomolybdic acid fine cherry-red, tannic acid precipitates yellowish-white. *Colocynthine.*
   - *f.* Sulphuric acid colors it brown, hydrochloric greenish; on heating, the liquid turns brown and clouds. *Erythrocentaurine?*
   - *g.* Sulphuric acid colors it clear brown, caustic potassa yellow, brown on heating; tannic acid gives no precipitate, nitric acid of 1·42 colors red. *Gentian bitter?*

   (Also sometimes a residue of *capsicine.*)

III. *Chloroform Residue.*

1. Crystalline.
   - *a.* Alkaline reaction none; sulphuric acid colors fine yellow; mixed with saltpetre ($NaNO_3$), then moistened with sulphuric acid, and finally, on adding a concentrated solution of soda, brick-red coloration. *Picrotoxine.*
   - *b.* Alkaline reaction. *Opium alkaloid.*
2. Amorphous.
   - *a.* No bitterness; caustic potash colors it purple-red. *Residue of aloetine.*
   - *b.* Bitter; caustic potash colors it yellow; obtained in crystals by dissolving in benzine and evaporating. *Residue of daphnine.*
   - *c.* Insoluble in ether.
     - *a.* Sulphuric acid colors it red-brown, tannic acid precipitates it. *Residue of quassine.*

β. Heated with dilute sulphuric acid, odor of menyanthole, liquid cloudy, and elimination of oily drops. *Major part of menyanthole.*

γ. Sulphuric acid colors it blood-red, then brown-red; hydrochloric acid greenish and brown on heating, cloudiness and elimination of oily drops. *Residue of cnicine.*

d. Soluble in ether.

α. Sulphuric acid colors it brown, afterwards blue-violet; sulphomolybdic acid same effect. *Residue of absinthine.*

β. Sulphuric acid colors it bright red, sulphomolybdic acid cherry-red, tannic acid precipitates yellowish-white. *Residue of colocynthine.*

γ. Sulphuric acid colors it brown, hydrochloric acid greenish, brown on heating, cloudiness and elimination of oily drops. *Major part of erythrocentaurine?*

B.—Agitation in Ammoniacal Solution.

I. *Benzine Residue Crystalline.*

1. Dilates the pupil.
   a. Platinic chloride does not precipitate the aqueous solution; the sulphuric acid solution develops a characteristic odor on heating. *Atropine.*
   b. Platinic chloride in sufficient quantity gives a precipitate. *Hyoscyamine.*
2. Does not dilate the pupil.
   Solution in sulphuric acid passes to blue with ceric oxide. *Strychnine.*

II. *Chloroform Residue.*

1. Sulphuric acid dissolves it in the cold without becoming colored.
   a. Solution colors a little on heating; after cooling is colored violet-blue by nitric acid. Feric chloride blues the substance, and sulphomolybdic acid colors it immediately violet. *Morphine.*
   b. The solution on heating turns violet-blue. *Papaverine.*
2. Sulphuric acid colors it grayish-brown, and the solution on heating becomes blood-red. *Narceine.*

III. *Amylic Alcohol Residue.*

(This agitation is not performed unless the presence of salicine is suspected.)

Sulphuric acid immediately colors it pure red. On heating with sulphuric acid and potassic bichromate, an odor of salicylic acid is developed. *Salicine.*

The characteristics designated in this table appear to be of such a nature as to afford an opportunity to discover the foreign substance which has served to give a beer the desired degree of bitterness; but they do not serve for the quantitative estimation of these substances, and even leave one in a state of uncertainty, unless the operations are repeatedly performed.—*Technologiste*, No. 399, 1874.

DETERMINATION OF GRAPE SUGAR BY THE COPPER METHOD.

BY F. MOHR.

Translated from Zeitschrift für Zuckerindustrie, by J. M. Merrick, B.Sc.

In the determination of grape sugar by the Bareswil-Fehling method, it is not always possible to observe closely the disappearance of a yellow cloud upon the surface, or the vanishing of the blue color of the copper solution; and especially is this the case with all colored fluids, red wine, beer, must, and the juice of sweet fruits. It has therefore been attempted to determine the sugar from the amount of suboxide of copper, and also by changing the suboxide into nitrate, and titrating with solution of cyanide of potassium. But since for this method a perfectly pure grape sugar is needed, the preparation of such a sugar will be first described.

The strongest possible grape sugar is dissolved in half its weight of water in a water-bath, and filtered into a glass funnel whose neck is stopped at the bottom with a cork. When the funnel is nearly full, it is covered with a glass plate and set away several months in a cool cellar, when the grape sugar again crystallizes out as a hydrate. The cork is taken out, and the fluid allowed to flow out; the sugar is covered with a layer of 80% alcohol, and this is displaced by more, until the sugar is dazzling white. It is dried in the open air, and then in a chloride of calcium jar. Heat should not be applied until most of the moisture is removed; otherwise the sugar softens in the remaining moisture, and cakes together. It is striking how little sugar crystallizes out if a starch sugar of only a small percentage is employed. The dextrin and other foreign matters hold the sugar in solution.

Grape sugar, by its reaction with oxide of copper in alkaline solution, decomposes 10 atoms of sulphate of copper. Since this reverts to Cu_2O, five atoms of oxygen have been removed. The suboxide of copper takes up five atoms of oxygen to return to oxide of copper. If this oxidation be effected with permanganate of potash of $\frac{1}{10}$ strength, with 3·162 grammes of the salt to one litre, a cubic centimetre gives $\frac{1}{10000}$ atom of oxygen, and every cubic centimetre represents $\frac{1}{5}$ part of $\frac{1}{10000}$ of one atom of grape sugar, or $\frac{\cdot 0198}{5} = 00396$ grm. In the ordinary sugar analysis the alkaline copper solution is first heated, and to this the sugar solution is added from a burette. There is at the beginning much copper solution in excess present; this gradually decreases, until at the end it is wholly destroyed. In the case where the sugar is not added from a burette, but put in all at once, weighed or measured, something similar takes place, only there is at the end copper solution in excess, and it must be ascertained whether the amount of this excess, which remains wholly unknown, exercises any influence upon the result.

Fehling's fluid was prepared with 34·64 grms. copper vitriol, tartrate of soda only 60 grms., and 200 c. c. caustic soda solution. Of this solution 100 c. c. correspond to one-half a gramme of pure dry grape sugar. It is always used in excess. Of this solution ·2 grm. require 40 c. c.; three portions, therefore, of ·2 grm. each are weighed out, and 50·70 and 90 c. c. respectively of copper solution added, heated to boiling; after heating put upon a fresh filter, washed out, and then further treated.

The suboxide of copper is best oxidized by acid sulphate of iron, in which it readily dissolves, and forms a corresponding amount of oxide of iron. This solution is preferable, on many grounds, to chloride of iron. No chlorine is formed, as there is no hydrochloric acid present; it has a much fainter color than chloride of iron, and the oxide of iron in the presence of free sulphuric acid is far less sensitive towards oxygen than is free hydrochloric acid. This solution is prepared by pour-

ing only slightly diluted English sulphuric acid over crude brown hematite or sesquioxide of iron and heating it to dryness in a porcelain vessel. Dissolve in warm water—an operation requiring time—filter, and test for oxide of iron with chameleon solution. In case this shows itself, conduct chlorine through the solution, leave it stopped up for some time, and test anew. As soon as none shows, open the flask, set in a warm place, and blow air through it repeatedly, to displace the chlorine. The concentrated fluid has a reddish-violet hue, but diluted is wholly colorless. The commercial double sulphate of iron and ammonia can be used in a similar manner, with the addition of sulphuric acid.

The above ·2 grm. of grape sugar treated in this way, and the iron-oxide determined with $\frac{1}{10}$ chameleon, demanded—

50 c. c. Fehlings' sol.	49·4 $\frac{1}{10}$	chameleon.
70 c. c. "	49·5 $\frac{1}{10}$	"
90 c. c. "	49·2 $\frac{1}{10}$	"

It makes, in reality, no difference whether much or little copper fluid is used, and the suboxide of copper can be looked upon as a measure of the grape sugar.

The determination with $\frac{1}{10}$ chameleon is incomparably sharper than that with cyanide of potassium, besides being more exact. It comprises one less operation, and a series of experiments with very different amounts of alkaline copper solution was made to compare the chameleon with grape sugar, with the assumption that one atom of this reduces ten atoms of copper oxide. The following are the results:—

Grape sugar.	C. c. $\frac{1}{10}$ ch.	1 c. c. $\frac{1}{10}$ cham. = grm. grape sugar.
·2 grm.	51·4	·00390 grm.
·2 "	49·4	·00404 "
·2 "	49·5	·00404 "
·2 "	49·2	·00406 "
·2 "	49·3	·00405 "
·3 "	70·0	·00420 "
·376 "	101·9	·00369 "
·5 "	128·0	·00366 "
·5 "	126·6	·00395 "
·5 "	132·7	·00376 "
·5 "	123·6	·00404 "
·5 "	131·0	·00382 "
·5 "	127·5	·00392 "
	Mean,	·003933 "

The mean result is close to the theoretical number ·00396, and we can assume that this is confirmed by the above experiments. No great error can be committed if we assume that 1 c. c. of $\frac{1}{10}$ chameleon = 4 milligrammes of grape sugar, since out of thirteen experiments only six gave a little more than 4 milligrammes.

It is not at all clear upon what the difference in the above numbers is founded—perhaps the suboxide of copper, small masses of organic bodies which act upon the chameleon. A perfect washing of the copper oxide is absolutely necessary, since the filtered fluid, saturated with sulphuric acid, deodorizes chameleon tolerably slowly, like oxalic acid, and not rapidly like protoxide of iron. In order to determine the value of a sample of starch sugar, it is only needful to weigh out corresponding amounts of this and of a pure sugar, to treat both with an equal amount of copper solution, and to determine the amount of the acid washed suboxide of copper in the above manner.

One-half a gramme of a commercial starch sugar was weighed out and determined as suboxide of copper with 93·4 $\frac{1}{10}$ chameleon: ·5 grm. pure sugar demanded 123·6 c. c., therefore the percentage is $\frac{93·4}{123·6} = 75·56\%$.

ON THE PARAFFINE INDUSTRY.

BY FREDERICK FIELD, ESQ., F.R.S.

In pursuing his celebrated researches upon the tar obtained from the red beech, Reichenbach discovered in the ultimate portion of his distillates a white translucent substance, to which he gave the name paraffine (from *parum* and *affinis*), owing to the comparatively slight action exerted upon it by most chemical reagents. The tar was submitted to repeated fractional distillations, and the portions passing over last were mixed with strong sulphuric acid and violently agitated. After standing in a warm place for some hours, the paraffine floated upon the carbonized residue in the form of a pale-colored oil, which, after cooling, solidified, and was pressed between folds of bibulous paper. By frequent crystallizations from boiling ether, it was obtained as a brilliantly white body, highly plastic and somewhat unctuous to the touch, but not greasy. This interesting hydro-carbon for many years was regarded as simply a chemical curiosity, "and so it remained," wrote Reichenbach many years after its discovery, "a beautiful item in the collection of chemical preparations, but never escaping from the rooms of the scientific man." I remember distinctly having a few grains sent me by Professor Abel, carefully inclosed in a glass tube, to add to my collection of treasures when I was in South America. It is now annually made, as will presently be shown, by thousands of tons.

Before entering into the immediate subject of the paper, viz., "The Paraffine Industry," it may be as well, in a very brief manner, to describe some of the properties of the substance itself. Paraffine is a pure hydrocarbon, having no oxygen whatever, and its analysis has given the following percentage composition:—

	Paraffine from Boghead Coal. Gattelly.	Paraffine from Boghead Coal. Anderson.	Paraffine from Gray Shale, Addiewell. MacIvor.
Carbon . . .	85·2	85·15	85.31
Hydrogen . . .	14·4	15·40	14·50

Paraffine, when pure, is perfectly colorless and translucent; after slightly warming, it becomes highly plastic, and can be moulded with the greatest ease. Hence it differs in some respects essentially from spermaceti, with which it has often been erroneously compared, as well as from stearic acid and other bodies used for the manufacture of candles. From this plasticity, paraffine candles in warm rooms (if not of a very high melting point) are liable to bend, while on the other hand, those made of sperm or stearic acid, although of a lower melting point, remain erect. Of course, as has been observed, this very much depends upon the fusibility of the substance, and the harder descriptions of paraffine are always selected for candles which have to be subjected to much heat. Liquid paraffine is very mobile, and can be filtered through paper almost as readily as water itself. It is scarcely acted upon, even by fuming sulphuric acid, unless at very high temperatures, so that it can be purified by this means from many other organic substances with which it may have been associated, they being immediately charred by contact with sulphuric acid. When submitted for a length of time to the action of chlorine or bromine, chlorinated or brominated compounds are formed, with disengagement of torrents of hydrochloric or hydrobromic acids. Mr. MacIvor,

who has devoted many years to the study of paraffine, says that after this body is acted upon by chlorine, it first becomes a gummy looking solid, afterwards a liquid colorless and transparent, and as the passage of the chlorine is continued, a hard brittle resin is the result. This substance consists of—

Carbon	29·55
Chlorine	66·82
Hydrogen	3·39
	99·76

This gentleman has also remarked that the paraffines having the highest melting point are those which are most easily acted upon by the gas. Iodine dissolves in paraffine, imparting to it a beautiful violet color, which becomes brown as the paraffine solidifies; but the action of this elemeut upon the hydro-carbon is very feeble, no apparent decomposition taking place after prolonged heating for many hours.

By the action of strong nitric or sulphuric acids M. Campion discovered a new body, which he calls "paraffinic acid," and describes it as a bright, transparent liquid, of a very inflammable nature. Strong nitric acid yields a series of interesting compounds, lately studied by Schorlemmer and others. Mr. Fordred informed me some years ago that when paraffine is acted upon by sulphuric acid, to which a few crystals of permanganate of potash have been previously added, the action is so violent that light and heat are evolved, and even at times accompanied by explosion. The best way of trying the experiment is to heat up the acid and permanganate in a tube, and drop a small piece of paraffine in the warm liquid. When they are all three placed together in the tube and heated up, the action is not nearly so violent. Success does not always attend the experiment, but it can be tried. The decomposition convinces us that the word paraffine (little affinity) is slightly a misnomer.

Paraffine is insoluble in water, very sparingly soluble in alcohol, even when boiling, more so in ether, and exceedingly in naphtha, sulphide of carbon, and aniline. When heated with sulphur at a moderately high temperature it is decomposed, carbon separates, and abundance of sulphuretted hydrogen is evolved. This fact may be of interest to chemists, as affording a ready source of this indispensable reagent in the laboratory. The two substances, the paraffine being in large excess, are heated together in a flask, when a steady and copious flow of the gas is obtained. We have here a tube containing paraffine and sulphur, and the characteristic action of the gas upon lead salts will be seen by the experiment. With regard to the beautiful translucency of paraffine, which in spite of certain drawbacks has made this body such an unusual favorite as a means of light, Mr. MacIvor informs me that if when melted it is cooled very gradually, and subjected to a slight and steady pressure, it becomes actually transparent, like ice, but that a blow or even a scratch will alter its molecular structure, and cause it to re-assume its normal appearance. As this change is also produced upon re-melting it, however cautiously, that triumph of manufacture in this department of industry, namely, making a transparent candle, is yet in the distance.

The specific gravity of paraffine has been variously stated at ·870, ·852, and ·880, and these discrepancies appear to have arisen from the fact that the experimenters have used different substances in their investigations. Mr. Gelletly has shown that the specific gravity rises with the melting point of paraffine. Thus paraffine melting at about 90° Fah. has only a specific gravity of ·823; at 128° Fah., which may be considered a very good average (rather high, perhaps), it has a specific gravity of ·911; and a specimen of an extraordinarily high melting point (176° Fah.) was as high as ·940, more than ten per cent. above that at 90° Fah.

In attempting to give a sketch of the paraffine industry, which in the space of time usually allotted must necessarily be brief and imperfect, I must be pardoned if many of the names of those who have done good service in this branch of manufacture are omitted, considering that there have been more than sixty patents taken out during the last few years for the treatment of solid and liquid hydro-carbons. To describe them all would be, it may be imagined, a weary task both for reader and listener.

Dr. Lyon Playfair, in the year 1847, called the attention of Mr. James Young to a dark, oily substance exuding from the cracks in the roof of a coal mine near Alfreton, in Derbyshire. This body was distilled, and yielded a pale yellow oil, which deposited, on cooling, small scaly particles which proved to be the solid paraffine. An establishment was speedily erected on the spot, and the product from the mine somewhat extensively worked, until it was exhausted or nearly so. In the mean time Mr. Reece obtained a patent (1849) for distilling paraffine from Irish peat, and works were erected near Ashby, in Ireland, for its production. It may be remembered by some amongst us, that at that time the natural resources of the sister island were the subject of much discussion, and the enormous amount of peat which is found in many localities was supposed to be, when properly treated, a source of unbounded wealth. It was stated that not only solid paraffine and illuminating oils could be obtained by its destructive distillation, but also acetate of ammonia and other valuable volatile products. The idea was very popular. A company was started, and although the promised compounds were produced, the expense of obtaining them, the quantity derived from the original peat being so small, led to a commercial disappointment. The following table may give some notion of the amount of materials obtained from the distillation of peat:—

Watery matters	30·614
Tar	2·392
Gases	62·392
Ashes	4·197
	99·595

The watery matters and tar yielding:—

Ammonia	0·287
Acetic acid	0·207
Naphtha	0·140
Volatile products	1·059
Paraffine	0·125

So that 100,000 pounds of peat would only yield 125 pounds of paraffine. Peat from the kingdom of Hanover appears to yield more than that from Ireland, 100,000 pounds yielding rather more than 300. Although in a monetary sense the Irish scheme was a failure, great credit must always be awarded to its promoters. It certainly led the way to other discoveries, and excited a wholesome interest in the hydro-carbon industry. The poverty of the original material operated upon appears to be the only cause of the non-success of the undertaking.

Mr. Young, having been successful in his experiments at the Derbyshire mine, but finding his stock of available materials drawing to a close, experimented upon nearly every kind of coal which he considered likely to yield solid or liquid hydro-carbons. With his usual sagacity, he imagined that there could be obtained by heating coal gradually by artificial means, such as the application of a low red heat, a product similar to the one naturally produced which he had first experimented upon at Alfreton. A highly bituminous coal procured from Boghead, near Bathgate, in the county of Linlithgow, was found to yield large quantities of oil, and a patent was granted to Mr. Young in 1850 "for treating bituminous coal to obtain paraffine and oil containing paraffine." An establishment was erected, and he was joined in this undertaking by Messrs. Meldrum and Binney. This Boghead coal, or Torbane-hill mineral, proved to be by far the richest source of paraffine and paraffine oil yet discovered, as much as 135 gallons or 50 per cent. of oil having occasionally been obtained as a product of distillation. Previous to the expiring of Mr. Young's patent in 1864, many works were in operation in Scotland for distilling oil from shale. Dr. Steele, of Wisham, erected several stills at Broxburn, which were eventually sold to Mr. Fernie, who again sold the establishment to a company (the Glasgow Shale Oil Company). There were also the West Calder Works, the Uphall Company, the Oakbank, the Levenside Oil Works, a few names amongst many more, but sufficient to give an idea of the extent to which, in so short a time, the paraffine industry had been developed.

In Wales, also, this manufacture was commenced about the year 1861, principally from three varieties of coal, namely, Curley cannel, which yields 30 per cent. crude oil, sp. gr. ·875 to ·890. Smooth cannel, which yields 16 per cent., sp. gr. ·925 to ·940; and Bastard or Common cannel, an inferior variety. At Leeswood, in Flintshire, the beds of cannel in some places were found to be six feet in thickness. Mr. Hussey Jones, of Leeswood, was, I believe, the originator of the paraffine industry in Wales. His works became the property of Messrs. Fernie and Company, who were defendants in the great suit of Young *v.* Fernie in 1864, lasting thirty-nine days, a trial still fresh in the memory of some of us, and which occasioned perhaps at the time as much excitement in the technical world as a certain great trial at Westminster has recently done among the public at large.

Although many chemists had announced the discovery that oils, etc., could be obtained by the distillation of shale and other minerals (see Christison, of Edinburgh, on "petroline" from Rangoon petroleum in 1831, Butler in 1833, Hompech in 1841, Du Bussey in 1845, etc., and many others even anterior to these), Mr. James Young, who was the first to make this industry a practical success and to establish it beyond doubt as a new means of benefiting mankind, must be regarded as the father of paraffine. "It is true," said Dr. Reichenbach, with the generosity that usually characterizes a great mind, "that the discovery of paraffine is mine, and I have announced it. To Mr. Young, however, belongs the merit of a second discovery, the merit of having elaborated a method which furnishes a comparatively large supply of this substance, and which is sufficiently remunerative to the manufacturer, a result which I have vainly endeavored to realize." The professor speaks of a comparatively large supply. The table before you will show how enormous this has become; the figures were given by Mr. Kennedy in his speech at the complimentary dinner to Mr. Hill, late manager of the extensive works at Bathgate:—

Shale used in Scotland . .	800,000 tons.
Crude oil produced . . .	25,000,000 galls.
Paraffine	5,800 tons.
Lubricating oil	9,800 "
Sulphate of ammonia . . .	2,350 "

To carry out this manufacture about 500,000 tons of fuel were required.

But yet it appears that the credit of first manufacturing solid paraffine on anything like an extensive scale is due to Messrs. William Brown and Company, of Glasgow, and I will read an extract from a letter addressed to the Secretary of Juries of the Universal Exhibition of 1862, by a very eminent London firm:—

May 20. 1862.

Sir—In reply to your communication received last week, requesting to be informed whether there is any peculiarity in the manufacture we exhibit, to which we are desirous of calling the attention of the jury in class 4, we beg to submit the following remarks: We have been using paraffine in the manufacture of candles since March, 1855. It was made by Messrs. William Brown and Company, of Glasgow, who were, to the best of our belief, the first makers of it in this country, and by whom we were regularly supplied; but from the smallness of the quantity produced (only three to four cwt. weekly) and its imperfection, especially in hardness, we abstained from offering candles made entirely from it, and merely employed it as an ingredient with other materials in the manufacture of the better class of candles. So far back as 1851, we had assisted, in becoming shareholders to the Irish Peat Company, in the attempt to obtain paraffine from the bogs of Ireland. It was not until November, 1856, that they were in a position to deliver paraffine, at which time we received supplies; and from this source, and a quantity of Rangoon paraffine, we, in March, 1857, manufactured and put in the market for the first time paraffine candles of English make. The price at which they were introduced was 2*s.* 4*d.* per pound. . . . .

Mr. Butler has been mentioned as one of those chemists who had experimented upon oils obtained from coal, etc., previously to the patent obtained by Mr. Young, and there is no doubt he found also solid paraffine among his products, as will be seen from the following statement:—Extract from patent granted to Richard Butler, Jan. 29, 1833 (forty years ago it must be remembered), No. 6375: When the residue of No. 2 distillate is exposed to a low temperature, there will soon appear small flakes of a white, odorless, and light substance, which is a compound of carbon and hydrogen." There can be little doubt, I imagine, that this was paraffine. Nearly all the oil and solid paraffine in Scotland is now made from shale. The last of the Boghead coal was, at the commencement of the year 1872, stacked in a field near Bathgate to the amount of several thousand tons, the greater part of which was destroyed by an accidental fire a few months afterwards.

The following is an outline of the processes employed in Messrs. Young and Company's and other large works for the production of the hydro-carbons: The shale is placed in the retort and heated, care being taken not to exceed low redness. This is of the utmost importance, as a higher temperature would inevitably produce gaseous products. When all the oil has ceased running, the operation is stopped. This crude product, which is

highly impure, is re-distilled, producing a certain amount of coke as residue, the distillate being technically known as "once run oil," a specimen of which is before you. This is agitated with strong sulphuric acid (in the original patent its own volume, but experience has shown that this quantity is not necessary), allowed to settle, treated with caustic soda, and re-distilled with steam, the products of distillation being fractioned. The first portion consists of naphtha, which is run in the general naphtha tank, to be ultimately distilled and fractioned to various specific gravities. The second contains the larger portion of burning oil. This is subject to two other treatments with acid and soda, and again distilled and fractioned; the first portion is placed with No. 1 distillate, and the last portion with No. 3. The third, heavy oil, is cooled and pressed for paraffine scale, of which mention will be made presently, and the expressed liquid treated with sulphuric acid, soda, distilled and fractioned until the desired specific gravity is obtained; and for its ultimate purification is again acidified, allowed to settle, and finally treated with soda. You will see from this that the crude oil appears to consist of three oils, naphtha, burning, and lubricating oil, the heavy oil being the one that contains the valuable solid product, and that these are separated after treatment with acid by means of distillation. The series before you, and to which your attention is invited at the conclusion of the paper, will show the physical character of the various products. The paraffine scale, which, you may remember, has been pressed from the heavy oil, a specimen of which is in this bottle and still contains much adhering oil and a considerable amount of color, is mixed with a portion of the naphtha obtained in the process, cooled, and subjected to severe pressure. The oil and softer portions, being more soluble than the solid paraffine, are dissolved, and a cake, diminished in bulk, is taken from the press. This is again subjected to a similar treatment, and if not sufficiently refined for its ultimate purification, undergoes another pressure with naphtha. The loss of this volatile hydro-carbon is somewhat heavy, and to obviate this Mr. Edward Meldrum patented a process, dated 4th June, 1867, No. 1646, for reducing the impure solid paraffine to a powder, and then introducing or mixing naphtha therewith, after which the mass is subjected to pressure. To give the exact words of the patent an extract may be quoted:—

"My said invention consists essentially in the purification of paraffine by treating it while in a cold, unmelted state with naphtha, instead, as heretofore, in a melted liquid state. In carrying out my said invention, I reduce the impure solid paraffine to a powder, and then introduce therein sufficient naphtha to make it into a paste or pulp, after which I subject the mass to pressure; or the solid impure paraffine and naphtha may be ground up together, and the mixture may be then subjected to pressure. By repeating three or four times the operation of re-grinding the paraffine to a paste or pulp with naphtha, and then squeezing it in a press, the paraffine can be freed from the heavy hydro-carbon oils with which it is contaminated in its impure state."

This must, it would be thought, save a loss in naphtha; but whether the process has been successful or not, I cannot say.

The cakes thus purified are melted in a still, through which free steam is violently passed, as well as confined steam in a worm at about twenty-five pounds pressure, in order to raise the temperature, until every trace of spirit is evolved and the condensed water contains no trace of naphtha. The product from the still is mixed with from three to five per cent. of animal charcoal, heat is applied, and the charcoal allowed to settle. Some finely divided particles remain, however, suspended in the supernatant liquid, and these must be separated by filtration. You will observe on the wall a diagram of a filter employed in the works of Messrs. Young. It consists essentially of a jacketed case kept hot by steam, and lined with a cylinder of wire gauze which is coated internally with flannel, and to make the filtration still more perfect filtering paper is introduced, so that the paraffine flows through absolutely free from solid particles, and, if pure, as colorless as distilled water. This is run into cakes of various forms and sizes, generally in shallow oblong tins. Messrs. Young, however, prefer the circular shape as more adapted for transport in casks. Specimens of either form are exhibited.

In the rapid description of the production and refining of solid paraffine from the oils and impurities with which it is associated, it will have been observed that naphtha or other light spirit was employed in its purification, the object being to wash out the greater part of the coloring matter by means of these solvents, and to render the partially purified substance fit for its final passage through animal charcoal. No process can be more successful, as the beautiful results of many eminent houses abundantly testify. But there is an amount of danger attending the operation which many manufacturers have endeavored to avoid, and some with considerable success. Two or three of the most important it may be as well to mention, first, the patent of Mr. John Fordred, No. 1858. A. D. 1871.

This gentleman, anxious if possible to avoid the use of naphtha or other inflammable liquid, imagined that by kneading, so to speak, crude paraffine scale in a slightly warm alkaline liquor, the alkali would probably form a species of emulsion with the oleaginous portions of the hydro-carbon, and the heat rendering the solid part plastic, the oils and coloring matter could be separated by a rough filtration. The earliest experiments were kindly explained to me by the patentee; a little bag, such as this, was filled with the crude scale, and after being soaked in warm water for some minutes, was kneaded by the hand exactly as, in lecture experiments, the separation of starch from gluten is effected, in the proximate analysis of flour, the starch representing the oil, the gluten the solid paraffine which remains in the bag. After many experiments the apparatus was devised, which is thus described in the patent, and of which a model is before you:—

"In carrying my invention into practice I proceed as follows: I take say one ton of crude paraffine, having, for example, a melting point of 120° Fah., and melt it carefully in an iron tank, and allow the mechanical impurities, such as tar, sand, and the like, to fall to the bottom; after a few hours' repose I run off the clarified paraffine into a number of flat metal trays, in which it solidifies into cakes, weighing about ten pounds each; these cakes are then placed edge to edge in a long bag of peculiar construction, and submitted to heat in a warm room, or in a bath of warm water till brought into a plastic condition. When this object has been attained, the bag of paraffine is submitted to the action of the kneading machine, which is supplied with a solution of soft soap in water, made in the following proportions: Soft soap 10 parts, water 10 parts, previously heated to about 100° Fah. This I call the soap bath. On the machine being set in motion, the oil and coloring matter contained in the crude paraffine will rapidly combine with the soapy liquor and form a temporary emulsion. I

find that any kind of soap soluble in water will answer for the above purpose, but I prefer to use the soft soap of commerce, and in the proportions named. I do not confine myself to the use of a bath of soap and water only, as I find that various other liquors will act upon the paraffine whilst in a warm and plastic condition, such as solutions of the carbonated and caustic alkalies, mixtures of these with solutions of soap, a solution of rosin in alkali, the residual acid or alkaline liquor deposited from acidified hydro-carbon oils after washing or neutralization, and, for some purposes, even warm water itself is sufficient."

The little model on the table will explain the necessary manipulation. The paraffine, previously freed from dross, etc., is placed in the bag, which is tightly fastened to the drum. This drum revolves, and by means of a little apparatus at the side, can be pressed nearer to a smaller drum underneath, which revolves in a contrary direction. In this manner the oil is squeezed out by a kneading process caused by the action of the spokes of the larger and smaller drums.

A second patent granted to R. M. Letchford and W. B. Nation, No. 890, A. D., 1872, comprises, say the patentees, two objects, first, economy in the materials and labor employed, and secondly, the freedom from danger arising from the use of paraffine oil in the usual methods of refining.

The process is conducted in the following manner:—

"We provide a tank, say about 12 feet by 6 feet and 2½ feet deep, divided by cross partitions into V form cells 2½ inches wide at the top and 2 inches at the bottom. The cells are open at the bottom, as the partitions stop short at 2 inches from the bottom of the tank; their upper ends are 9 inches from the top of the tank; there is a space of about 1 inch between cell and cell; there is a perforated lid or grating to fit into the tank resting on the top of the partitions. A grating with bars 1½ inches apart is suitable. We fit steam pipes (free or closed) into the tank below the partitions. In using this apparatus we run water into the tank to the depth of 6 inches and fill crude paraffine into the cells of the tank, and then secure the lid or grating to prevent the paraffine floating. We run more water into the tank to within 2 inches of the top, and turn on steam until the temperature of the water is within about 10° Fah. of the setting point of the paraffine under manipulation; then we shut off the steam to allow the heat time to permeate the material. In about one hour we increase the temperature, raising it gradually for about four hours to within 2° of the setting point of the paraffine that was put into the tank; then we shut off the steam and take off the soft portions which have floated to the surface of the water. This being done, we run the water off to the top of the divisions, then melt the remaining paraffine in its cells, and let it stand to cool all night. In the morning the steam may be turned on again to repeat the operation, which is done as often as necessary to obtain the purity and hardness required. It is rarely necessary to do so more than four times; or the process may be conducted by first melting the paraffine in the cells and then cooling to 2° below the setting point of the material. We then secure the lid, add more water, and float out the soft portions. In either way we finally remove the lid and take out the paraffine from which the low melting portions have been extracted; the low melting portions which have been removed are to be again treated like the crude.

"For obtaining fine degrees of whiteness, when the foregoing operations have been carried far enough, we remove the clean paraffine to a steam-jacketed pan, adding thereto about 7 per cent. of commercial ivory black in powder, and keep it melted for four or five hours, until the whole of the ivory black is precipitated. We then cast into cakes in the usual way; the ivory black may afterwards be used advantageously in making blacking."

There is one more patent which may be mentioned, among a host of others (No. 3241, A. D. 1871, granted to Mr. Hodges):—

"The crude paraffine, having, if desired, been first separated from rough impurities, is cast into cakes and allowed to cool slowly, so as to form into well-developed crystals. The cakes are then placed on a bed of absorbent or porous material, and are, while thus placed, exposed to a warm temperature, sufficient to render fluid the more easily melted portions with which the crystallized paraffine is mixed, but insufficient to melt the paraffine. The fluid and more easily melted portions then flow out from between the crystals of paraffine, and into, or into and through, the absorbent or absorbent and porous materials on which the cake rests. The cake—thus freed from the fluid, or fluid and more easily melted portions—may then be treated in any usual method to render it white, or as much lighter in color as may be practicable; or the process may be repeated until the separation of the harder from the softer portions has been effected as completely as is desired, and then any requisite process for whitening the product may be adopted if needed."*

It will be seen that all these processes have for their object the removal of the liquid from the solid hydrocarbons. It would be out of place to give one the preference over the other. Each of the patentees considers, doubtless, that his idea is the best.

The partially purified paraffine, as you will observe from the specimens on the table, is by no means colorless, and upon a closer examination will be found still to possess considerable smell. One method for its further purification may be thus described. Let us take, for example, this material obtained according to the patent of Mr. Fordred. After being melted by free steam to separate any water or alkali which may be mechanically retained, it is poured into a tank and agitated, by means of air, with from five to ten per cent. of strong sulphuric acid, the sulphurous acid evolved, resulting from decomposition, is conveyed away by a suitable apparatus. The agitation is carried on for some hours, very much depending upon the nature of the paraffine, and the experienced manufacturer can easily tell when the desired result is effected. Here are various specimens before us of acidified cake, as it is termed, both before the tarry mass has subsided and after remaining at rest for some hours. It will be observed that that which is immediately drawn off is darker in appearance than that which has been allowed to rest, containing as it does a large quantity of black specks, an aggregate of which is seen in the sample of tar in this dish. The best of these products is still, however, far from white, and the acidified paraffine has yet to undergo a further treatment. Animal charcoal, the substance previously mentioned as a bleaching agent, is generally employed. The paraffine is warmed and digested with the charcoal for some hours; the latter is allowed to subside, and the liquid, if not quite bright, is passed through a filter kept warm by a steam-jacket.

* This process is carried on upon a large scale by Price's Candle Company, and the manager has kindly lent me a model in order to illustrate its working.

But lately other bleaching agents have been used which are deserving of notice.

A patent was granted to Messrs. Fordred, Lambe, and Sterry, in A. D. 1868, No. 610, for the use of fuller's earth as a decolorizer of paraffine and other bodies, an extract of which may be quoted:—

"Fuller's earth we also use for finishing the bleaching of paraffine in lieu of animal charcoal, whatever the previous process of purification may have been. In that case about 12 per cent. powdered fuller's earth is added to the melted paraffine, which is manufactured at a temperature of about 230° Fah., and well agitated, and after subsidence the clear paraffine is run off. We find that in all our processes, where we have mentioned fuller's earth as the agent to be employed, we can replace that substance in great part or wholly by marl, clay, or other readily attainable natural substance of like character. The fuller's earth or analogous substances used in place thereof in any of the ways stated above, may be re-used, and the paraffine remaining adhered may finally be recovered from it by washing with agitation or by other suitable means."

This process is so simple and expeditious that it may be shown as a lecture experiment, and while the earth is being added, and the paraffine brought to the required temperature, and the particles allowed to settle, I will proceed to notice another method of bleaching lately patented by Mr. Arthur Smith and myself, which in many respects obviates certain disadvantages that accrue from the use of fuller's earth. Fuller's earth and many other natural silicates are undecomposable even by strong acids, although certain silicates of lime or magnesia or both these bodies are decomposed when the acids are concentrated, forming a gelatinous residue of silica and solutions of the bases. It occurred to us that, by forming artificial silicates, and employing them instead of natural, as proposed in the previous patents mentioned, these compounds might be employed, and the paraffine or other hydro-carbons separated by the addition of very weak acidulated matter. We experimented with the silicates of lime, magnesia, manganese, iron, and some others, and although all answered admirably, we came to the conclusion that the magnesia salt was the best, a less amount being required to insure the full bleaching action required. At the first glance, any of these substances, even the lime salt, seems too costly to admit of practical application, but it will be shown presently that this is not the case. The process of manufacture and of the re-construction of the salt may be illustrated by the row of beakers before you on the table.

No. 1 contains a solution of sulphate of magnesia.

No. 2 a solution of silicate of soda.

When the contents of these two beakers are mixed, there is, you will observe, an immediate precipitate of silicate of magnesia. This is washed thoroughly by decantation. The washing is exemplified in beaker No. 3.

No. 4 contains the substance dried by steam heat.

No. 5 contains the acidified paraffine, which, when liquefied, is ready for the reception of the silicate.

No. 6 was exposed before the lecture to the action of the silicate, which has subsided as a dark mass, leaving the paraffine pure and colorless.

No. 7 contains a quantity of the contaminated silicate, which in No. 8 has been subjected to the action of weak acid, and you will observe three distinct divisions. That on the surface is the separated paraffine; the centre a solution of the sulphate of magnesia; and at the base precipitated silica. The sulphate of magnesia arising from the decomposition of the silicate by sulphuric acid is neutralized and placed in glass

No. 9, and the precipitated silica after washing, is dissolved in caustic soda and removed to glass

No. 10. Nos. 9 and 10 when mixed produce, as you see, the original salt employed, so that really, after the first cast, we can re-form the silicate at the expense only of sulphuric acid and caustic soda.

It is very important to mention that the success of this process depends upon the purity of the salt and the manner in which it is dried. If the gelatinous mass in that beaker were simply desiccated without previous washing, and the soluble saline body (in this case sulphate of soda) retained, the porous structure, or whatever it may be of the silicate, would be, so to speak, stopped up, and all bleaching action impeded. And if the washed product were heated to redness, its decolorizing power would also be destroyed. It must be dried at 212° and no higher, and thus the far cheaper and simpler operation of fusing silica with dolomite is inadmissible; the resulting silicates would be valueless. Fuller's earth, which is simply ground, contains naturally a large quantity of water, and this substance also, if heated to redness, is of no avail in paraffine refining. And yet a more singular fact is this, that although we must have a hydrated compound, no bleaching action takes place until the water is separated. Melted paraffine, as far as my own experience extends, may be agitated either with fuller's earth or artificial silicate for any length of time, without any perceptible action, at a temperature slightly higher than its melting point. The color seems to disappear when the water is driven off, as if it took its place, and could not be dissolved from the hydro-carbon, however long the operation might be extended. By this time, it may be hoped, you will be enabled to see the bleaching action of the fuller's earth in the experiment which was prepared a short time back, and is now awaiting completion.

It must not be supposed that the bleaching action of the two substances that have just been discussed is confined to solid hydro-carbons. Paraffine oil is rendered water-white by digesting it at a moderate temperature, with either fuller's earth or an artificially prepared silicate. In conclusion, a few of the applications of this beautiful substance may be briefly enumerated. Independently of its chief employment as a source of artificial light, through the medium of lamps and candles, it has been advantageously applied for other purposes. It has been proposed to saturate gunpowder with melted paraffine, in order to retard its explosive action, if required; it having been ascertained that a smaller sized grain might be substituted for a larger when subjected to this treatment. The powder is digested with the paraffine, and the excess of the latter removed by steam heat. It is a non-conductor of electricity, and has been used extensively as an insulator in electro-telegraphic science. It has also been employed, when dissolved in naphtha, as a preservative of stone and brick-work, permeating the interstices of the mass, and repelling the action of wind and rain. When melted with India-rubber it produces a good water-proof compound, which can be applied to wearing apparel. It has been used advantageously for polishing cloths, giving them a fine and smooth surface. Dr. Lawson Tate has made use of paraffine in surgery, employing it as a covering for splints in fractured limbs with very considerable success. The laundress has discovered that by rubbing a small piece of paraffine on a warm flat-iron, a beautiful gloss is imparted to linen, and the humble manipulation

is much lighted by the ease and celerity with which the iron travels over the clothes, at the same time leaving no greasy stain in its track. The horticulturist has also found that paraffine, when mixed with bees-wax, can be excellently applied in the budding of roses, or the grafting of fruit-trees. Mr. Veally has shown that it is most useful in the preservation of beer barrels, preventing them from becoming foul; and it would be difficult, at the moment, to narrate its many applications, or to speculate upon its future. As paraffine will not dissolve the aniline colors, it may be asked how the beautiful tints are produced which serve to embellish the candles you see before you. The colors are dissolved in stearic acid, which is afterwards diluted with the paraffine, the color remaining in a mechanically suspended state. If a candle, slightly tinted, is melted, and the liquid passed through bibulous paper, the filtrate is white and the dye remains on the filter.

The insolubility of certain coloring matters, especially those from aniline, may be employed successfully in determining the freedom of paraffine from stearic or other fatty acids. The specimens before you may illustrate this fact. The first specimen is that of paraffine which has been subjected to a temperature of 212° with rosaniline. The second is the paraffine fused with two per cent. of stearic acid, and has, you will observe, a distinct pink color. The third sample contains five per cent. of stearic acid, and the crimson color in this instance fully developed.

Petroleum and the mineral ozokerit, both closely identified with the paraffine industry, would each demand a separate lecture, and however pleasant it would be for me to speak about these interesting bodies, I feel that I have exceeded the time allowed me, and that your kind attention has already been exercised too long.

DISCUSSION.

Mr. F. A. Abel, F.R.S., said he had been much interested in the lucid account given of the paraffine industry, especially with regard to the purification and the different applications of the paraffine itself. He had himself from time to time become practically acquainted with some of its applications, for instance as a means of retarding the explosive properties of gunpowder. Some extensive experiments were made in that direction in 1867 and 1868, at Woolwich, with different kinds of gunpowder. The grains were immersed in a bath of melted paraffine for a short time, and afterwards allowed to remain at a temperature of about 180° or 200° Fah., so as to allow the paraffine to thoroughly impregnate the grains, and the result was that the gunpowder became remarkably repellant of water, so that it might be preserved almost under water for some time without any great tendency to change. It also had the effect of retarding the combustion, so that the powder might be made to burn comparatively slowly, but on attempting to obtain a powder so treated which was available for projectile purposes it was found that a very great loss in power was sustained. According to his recollection, in guns of nine-inch calibre it was found necessary to employ sixty pounds of gunpowder so treated to obtain the same velocity as that given by forty-five pounds of unprepared powder; it was also found that the comparative slowness of the combustion increased the recoil, and largely increased the fouling, because of the non-volatilization of the paraffine and the retention of a portion of unburnt carbon. On the whole, therefore, the results were not so valuable as was anticipated, and it was found better to obtain the end sought by increasing the size of the grain, and the density and compactness of the masses. He had also become acquainted with another application of paraffine to the preservation of stone, having been consulted with regard to several processes for preserving the stone of the Houses of Parliament, some of the most promising of which consisted in the application of paraffine in different ways. It was found, however, that when applied after being heated to any considerable extent, the effect was decidedly detrimental, and the stone decayed much more rapidly than when left to itself; on the other hand, when applied with solvents, or at a very low temperature, it furnished more promising results. It had also been found very useful as an application to different fabrics for rendering them water-repellant, and it had been very useful in this way in connection with military equipments—for the preparation of tent cloths, sheets on which soldiers might lie during the night, treating the soles of boots, and for various other similar purposes. The late Dr. Livingstone had written to Dr. Stenhouse saying how grateful he had been to him for sending out some boots and ground sheets which had been prepared in this way. He should have much liked to have had some further information with respect to the peculiar property of paraffine—the great variations in the hardness of the material; sometimes it was almost so soft as to be readily moulded by hand, whilst at others it was comparatively hard. He recollected that in the early introduction of paraffine candles, sometimes they were so soft as to be very readily bent, and he should like to know whether this was simply due to a difference in the refining, or whether there might be different varieties of paraffine possessing different degrees of hardness, with which they might hope to become more thoroughly acquainted by-and-by.

Mr. Fordred said one property of paraffine which had not been noticed was its great tendency to become discolored. He had examined very many specimens in different manufactories, but he had never found one which would permanently stand the action of light; it always became more or less discolored in the course of time. A gentleman who had visited the Vienna Exhibition had told him that on mentioning this point to German chemists they said it was utterly impossible, and quite laughed at the idea of obtaining a changeless paraffine.

Mr. Grazebrook remarked that amongst the different uses of paraffine, one of perhaps as much practical use as any, if more generally adopted, was the lining of casks and barrels, for which it was eminently adapted. It was a perfectly pure material, which would not taint, and it had the further great advantage that it prevented the escape of carbonic acid gas by filling up all the pores and joints in the wood, thus fulfilling a great desideratum for the perfection of condition in both beers and wines. He believed it only required to be more generally known to be extensively used for this purpose. One of the great advantages of the Vienna beer was that it was kept in casks which were lined with a preparation of resin, but there could be no doubt that paraffine was in every respect a preferable material.

Mr. Abel said he was reminded by the observation of the last speaker of another application of paraffine which was a very valuable one. It was very difficult of attack by any chemical agent; so much so, that it might be left in contact with concentrated acid without undergoing any change, and this had led to its use as a material for lining the wooden boxes used in the construction of voltaic batteries which contained strong sa-

line or acid solutions. Some years ago, when the manufacture of gun-cotton was first attempted experimentally in this country, the vessels in which the cotton-wool was to be converted into gun-cotton consisted simply of soft wood thoroughly lined inside with paraffine, and these were used for several weeks together without any action upon the surface by the strong sulphuric and nitric acids. It was only when by some slight accident a part of the paraffine coating became removed that the acid got access to the wood, and of course an oxidizing effect was produced at once.

Mr. Field, in reply, said he did not think the difference in the melting point of the different samples of paraffine was as yet understood. He had samples upon the table of paraffine, the melting points of which varied from 130° to 135°, being as hard as it was possible to make it, and there were others with melting points as low as 90°, which were yet exactly of the same chemical composition. He might mention, however, that a paraffine of low melting point had always a lower specific gravity than one with a higher melting point. Thus, there would be about 10 per cent. difference in specific gravity between two samples whose melting points were respectively 90° and 140°. It was very remarkable, however, that if stearic acid, which melted at 130°, were mixed with paraffine which melted at 130°, the product would be a fusible mass which would melt at 114°; and if you take a paraffine with a lower melting point, say 90°, and mix it with stearic acid, you get an actual liquid product which would keep liquid at the ordinary temperature of a room. This seemed analogous to the fusible alloy made of lead and bismuth, which would melt at a point much below either of the metals employed.

A vote of thanks to Mr. Field was then proposed by the Chairman, and carried unanimously. A similar compliment to the Chairman himself terminated the proceedings.—*Journal of the Society of Arts.*

THE OXYHYDRIC LIGHT.

In our issue of the 16th of August we mentioned the decision which had been arrived at by the Municipal Council of Paris, based upon the conclusions of the report of M. Louvet, and that permission had been refused to the Tessié du Motay Company to establish mains for the distribution of the oxyhydric light to public and private consumers. Permission had previously been accorded to lay down mains for a distance of 8000 metres, and M. Félix le Blanc, gas inspector, had been instructed by the Prefect of the Séine to follow, with M. Darcel, engineer-in-chief to the service of gas lighting, all the trials made at various times with the oxyhydric light, and to complete these trials by the experiments necessary to clear up doubtful points—experiments made in the presence of the representative of M. Tessié du Motay. M. le Blanc has recorded his experiments in a report, which served as a foundation for that of M. Louvet. We have before us both these reports, and although the question of oxyhydric gas has for the present been definitely decided at Paris, it is still being considered elsewhere, and we think it will be found of interest if we explain the manner in which the various experiments were made, and the principal results obtained.

The first invention of M. Tessié du Motay consisted in projecting a mixture of ordinary coal gas and oxygen, not on a pencil of chalk, as in the Drummond light, but on a cylindrical stick of compressed magnesia, or even on a piece of zircon. The light thus obtained is, as is well known, very brilliant, and the discovery made by M. Tessié du Motay of an economical mode of producing the oxygen, led him to think that his new system of illumination presented important advantages. His process of manufacture is based on the employment of manganate of soda, decomposed by a current of superheated steam. This reaction disengages the oxygen at red heat. The soda is then regenerated by the passage of a current of air, which revivifies it by leaving its oxygen behind it. This alternate operation of abstraction and regeneration can be repeated almost indefinitely.

Subsequently the Tessié du Motay Association abandoned the use of refractory pencils, either of magnesia or zircon, made incandescent by the action of the ignited jet of mingled gases, and adopted a new system, which consists of projecting the oxygen in the axis of a flame obtained by the combustion of coal gas, previously charged with the vapor of volatile oils rich in carbon. This effect is produced by means of special burners delivering the hydro-carburetted gas around their circumference, and the oxygen in the centre, the two gases being led to the burners by a separate system of mains and service pipes. The flame thus obtained is very bright if the two gases are blended in the proportion of 1 of hydro-carburetted gas to ½ or a little more than ½ of oxygen by volume.

When authority was granted to M. du Motay and his colleagues to distribute his gas experimentally in Paris, for a distance of five-eighths of a mile, they did not employ the ordinary gas, but laid down besides the pipes required for the oxygen, a second series, to lead to the burners, rich gas distilled from Boghead coal. This fact, taking into consideration the short distance from the burners to the reservoirs, has led M. le Blanc to remark, in his report, that the company was working under conditions very different to those that would be met with, supposing that a general concession for canalization was conceded to them. The engineers of the company acknowledged themselves that their experiments did not conform with the condition of every day practice.

A double series of trials was made under the direction of M. le Blanc. 1. In the public streets, and 2. in the laboratory, and in the dark room of the gas-testing service of Paris. In these experiments the oxygen was burnt, 1, with Boghead coal gas; 2, with carburetted coal gas; and 3, with the ordinary gas of Paris, without any previous carburization. We may speak first of the experiments made in the public streets. They were conducted on the Place du Nouvel Opéra, with two lamps, the first being supplied with the mingled gas, and the second with ordinary coal gas, and these served to give comparisons of luminous intensity—comparisons made by means of the photometer. At the foot of the first lamp two gas counters were fixed, the one intended to measure the oxygen, the other the coal gas. The consumption in litres of each was thus obtained per burner and per hour. The Oxyhydric Light Company was allowed to attach to each counter a Girard regulator, to obtain for the gases a suitable pressure, and the apparatus, once regulated, remained constant.

The basis of all the calculations determining the results of the experiments, is the price of the oxygen—a price determined by the society itself. This has been fixed at 0·50 franc the cubic metre for the city, and at double that price for private consumption. The reporters consider this price as too low, especially when

the cost of carburetting the combustible gas is taken into consideration, and they conclude that only under certain conditions the numerical results deduced from experiments must be accepted, and that certain of these results which appear favorable to the employment of the oxyhydric light are apparent rather than real.

It must be remembered, also, that one of the data that must be used in making a comparison of price between the oxyhydric and the common coal gas, with equal light, is the price of the latter, which in Paris is three-tenths of that proposed by the company for the oxygen for public consumption, and three-fifths that for private use. In the first series of experiments made on the Place du Nouvel Opéra, with the Boghead coal gas, two kinds of oxyhydric burners were employed—the bat-wing, No. 2, of average consumption, with a short spread-out flame, and a large jet, No. 3, with a long straight flame, and of large consumption.

Bat-wing burner, No. 2. With this burner, the average consumption per burner and per hour was—

Boghead coal gas . .	2·340 cubic feet
Oxygen	0·998 " "

The photometer indicated an illuminating power of 1·7, the light given by the ordinary gas burner being taken as 1. The total price for the city, per hour and per jet, at the price previously given, will be thus:—

Boghead coal gas .	2·340 cubic feet	·663 pence
Oxygen	0·998 " "	·141 "
Total		·804 "

With an ordinary jet, burning the common coal gas, and consuming per hour 4·942 cubic feet, the expense is ·21 pence. The proportion between the prices is thus $\frac{·804}{·210}$ pence per jet and per hour. But the lighting power of the oxyhydric gas being 1·7 times greater than that of the common gas, the proportion of prices, with equal light, will be—

$$\frac{·804}{·210 \times 1·7} = 2·25$$

The oxyhydric gas used under similar conditions would thus cost the city 2·25 times as much as the ordinary gas.

For private consumers the price of oxygen, as given by the company, being 1 franc instead of ·50 franc, and that of the ordinary gas ·30 franc instead of ·15 franc, the proportion of prices of the two kinds of lighting, the degree of illumination being equal, would be 1·32 instead of 2·25.

The difference in this case is less striking.

With the large burner No. 3 the consumption per jet and per hour was—

Boghead coal gas . .	3·558 cubic feet
Oxygen	2·580 " "

In proceeding with the computation as before, and allowing for the increased illuminating power, which is 3·3 to 1, it is found that with an equal light the oxyhydric light, with jet No. 3, would cost twice as much to the city as the ordinary coal gas; for private consumption it would be 1·25 times greater.

A second series of experiments was made with the public lamps upon the carburetted coal gas and the oxygen. The Lenoir carburator was employed, and the liquid used was Boghead coal oil, worth about 5½*d.* per pound. The average consumption of oil per cubic foot of gas was 32·25 grains. Working from the data obtained from these experiments as before, and admitting always the prices fixed by the company, it is found that the proportion between the prices of the oxyhydric and the ordinary gas, with equal light, is, for the city use, equal to

$\frac{2·2}{2·3}$ with the large burner No. 3,

$\frac{1·14}{1·30}$ " butterfly jets, No. 2,

$\frac{1·13}{0·6}$ with a smaller burner No. 1.

At the conclusion of the experiments made in the streets, the engineers of the Tessié du Motay Company appeared to appreciate the many grave difficulties which lay in the way of its adoption for public use, and turned their attention to making it available for private consumption.

The experiments, conducted in the laboratory of the service for testing gas, dealt with many different modes of lighting, several of which have only an indirect bearing on the oxyhydric gas. We need only refer to those made with the Boghead coal gas and oxygen, and with carburetted gas and oxygen.

The former, conducted with different burners, showed, that even with the most advantageous forms of jet, that is to say, with the large burner, No. 3, economical results, with equal illuminating power, could not be obtained. In the trials made with the carburetted gas and the oxygen, the Lévêque carburator was used in accordance with a wish expressed by the engineers of the company. In this carburator the vertical wicks are immersed at their lower ends in the hydrocarbon, which rises throughout their length by capillary attraction. The gas circulating around the moistened surfaces is charged with the vapors which are given off by the volatilization of the oil.

Experiments were commenced with Boghead oil, of the price of about sixpence a pound. Although this liquid gives very valuable results as regards the illuminating effect produced during the different periods of volatilization, it is preferable in all respects to the preparations of petroleum, which are still more variable.

The jet No. 1 (*bec bougie*), experimented with at first, did not give favorable results. With a jet of the same form, No. 2, the proportion of price between oxyhydric and common gas lighting, with equal illumination, and for private consumption, was found equal to $\frac{1·38}{2·55}$. These figures would indicate in this case a marked economy. But this advantage, according to the reporters, is not real, because it is only obtained by powerful carburation, the expense of which does not appear to have been ascertained by the company.

The same remark is applicable to the results obtained with the large jet, No. 3. This burner was the object of a great number of experiments made under varying conditions with the Lévêque carburator. The rest of the experiments, compared like the preceding ones, showed that it is with the burners of large consumption that the greatest advantage is obtained in regard to the lighting power as compared with the cost of the gas. The lighting power increases much more rapidly than the consumption, showing that the oxyhydric gas does not give a divisible light, that is, that it does not permit of the advantageous employment of small jets of low consumption.

Employing always the prices fixed by the company

in computing the results obtained with the large jet, No. 3, a great economy is arrived at. The reporter concludes that, if the selling prices for the oxygen could be considered trustworthy, and that if it was not necessary to take into account a greater degree of carburation than is provided for by the company, the oxyhydric gas consumed in burners of large consumption could supply light at a lower price per unit than common coal gas.

He observes, however, that the light from these burners is at all times too powerful for private use, and that it has to be reduced by the interposition of ground or enamelled glass, which obscures from 25 to 30 per cent. of the light emitted.

The experiments, conducted by M. le Blanc, appear to have been made with the greatest care. All the doubtful points that required to be investigated, he has examined. It would have been interesting, however, had he experimented upon the action of cold upon the carburator. Had he done so, he would probably have found a new argument against the use of the oxyhydric light with carburetted gas.

We must conclude this article with an extract from the report of M. Louvet. His conclusions, although they strongly recommend the rejection of the request to lay down a system of mains in Paris, contains so high an opinion of M. Tessié du Motay's labors, that we cannot pass them in silence. "Your Commission," says M. Louvet, "believes that it should testify to the perseverance, to the investigations, and to the efforts of M. Tessié du Motay, thanks to which he has really found the means to produce oxygen under conditions more advantageous than haye ever before been accomplished; he has made a discovery which, sooner or later, will render immense service to industry. But for the present, the claims advanced to support the demand addressed you do not appear to be clearly enough established for the municipal authorities of the city of Paris to convert the canalization for the benefit of a system of lighting inapplicable for use in the public streets, and to assume thus, by a premature sanction, a great moral responsibility."—*Engineering.*

ON PHOSPHORIC BRONZE AND ITS PRINCIPAL INDUSTRIAL USES.

BY M. C. MONTEFIORE LEVI, VAL BENOIT, LIEGE.

Although the subject of the present note might be considered as not strictly within the limits of the subjects to be submitted to the discussion of the Iron and Steel Institute, it nevertheless bears such an intimate relation to the methods of manufacture of iron and steel, that we do not hesitate to bring it under the attention of the Institute.

Our intention is not to establish any comparison between phosphoric bronze on the one hand, and iron and steel on the other, although such a comparison might present a certain interest, but if we take into consideration the importance of being able to produce by casting, that is to say, independently of any complication of shape, a metal possessing the qualities of hardness, absolute resistance, and elasticity in a higher degree than iron, and almost equal in certain cases to steel, together with the faculty of varying at will, and within very wide limits, any or all of these qualities; when, moreover, the metal may be considered as practically inoxidizable, when it shows but a slight friction against iron or steel, when it does not vary in structure by shocks or concussions, however often repeated, and preserves the entire intrinsic value of the metal when worn out or otherwise out of use, it will be admitted that the study of the qualities of such an alloy is of considerable interest to all who construct or use the numerous tools and powerful engines required for the production of iron in its many varieties.

The attention of the readers of English and foreign reviews and scientific journals has been on more than one occasion drawn to phosphoric bronze. We may specially mention the *Engineer* of the 8th July, 1870, and the 23d February, 1872, and *Engineering* of the 9th September, 1871, and 4th October, 1872. These articles refer more particularly to the origin and to the first trials and industrial applications of phosphoric bronze.

Prolonged experience in the manufacture has produced a more perfect knowledge of the properties and preparation of the alloy; it is thus that a far superior degree of resistance and elasticity has been attained, whilst it has now become easy to give either of these qualities the desired predominance together with more or less hardness according to the special purpose to which the metal is to be applied.

The following table shows the result of five trials of tensile strength, made by Mr. Kirkaldy upon bars composed of one identical alloy, submitted to different processes of manufacture:—

Nos.	Ultimate Stress per Square Inch.	Elastic Stress per Square Inch.	Ultimate Permanent Extension.
1 . . .	74·966	55·800	2·53
2 . . .	73·987	55·200	3·20
3 . . .	63·653	40·500	9·40
4 . . .	54·060	26·300	31·30
5 . . .	50·120	21·700	39·10

The Ministry of Public Works for Germany, struck by the remarkable qualities of the alloy, ordered, as a work of public utility, a series of trials to be made at the expense of the government. As these trials, similar in nature to those made constantly during the last eight years upon the iron and steel employed in the manufacture of rolling stock and railway plant, are of considerable importance, we will in a few words describe the means used and the end attained.

The trials at Berlin have proved the correctness of the hypothesis so often broached, that iron and steel, if submitted to continually repeated efforts of tension, torsion, or flexion, give way, probably in consequence of a molecular modification of structure under an effort often considerably below that of their absolute resistance under one single strain.

These trials were undertaken by the Prussian government with the object of establishing as a fact, that the absolute resistance and elasticity of a metal being known, such metal can only with perfect security be submitted to a limited given number of strains of a given strength in all cases inferior to the limit of its absolute resistance. M. Reuleaux, Conseiller intime, and M. Spankenberg, engineer, are conducting these trials with phosphoric bronze. Highly interesting and elaborate details of the methods and apparatus employed by them may be found in the work of M. A. Wöhler, entitled "Ueber die Festigkeitsversuche mit Eisen und Stahl. Berlin, 1870. Ernst ü Korn."

The first series of these experiments with phosphoric bronze, as compared with ordinary bronze or gun-metal, were begun in April and ended towards the middle of May of the present year, with the following results:—

A bar of phosphoric bronze was submitted successfully to 408,230 tractions, with an effort of 200 cwt. per square inch, whilst a first bar of ordinary bronze broke at an effort below 200 cwt., and a second bar resisted only 4200 tractions. A second bar of phosphoric bronze has, at the present time, resisted 147,840 tractions with an effort of 250 cwt. per square inch, and this experiment is still in progress.

In a trial for flexion, with a maximum strain of 200 cwt. on the external fibres of the bar, these fibres alone were broken through after 862,980 flexions, whilst a similar bar of ordinary bronze, under the same strain, was broken completely through after 102,650 such flexions. A second bar of phosphoric bronze, under an effort of 180 cwt. per square inch, has, up to this date, borne 1,260,000 flexions without as yet showing any sign of deformation or of rupture.

We now come to a series of industrial applications. A peculiar composition of phosphoric bronze, destined specially to resist friction, has been in use for several years on a large scale for bearings, particularly for rolling stock, and, among others, the Grand Central Railway Company, of Belgium, employed these bearings exclusively for all its cars and carriages. Many works, both in Belgium and Germany, employ this alloy for engine and machinery bearings. The trials made have shown that the wear by friction is about five times less than that of ordinary bearing brasses, whilst the axles remain unaltered. Several ironworks, among which we may mention Messrs. Gillieaux & Co., at Charleroi, Blondiaux & Co., at Thyle-Chateau, Thorneycroft, at Wolverhampton, and De Wendel & Co., at Hayange, make constant use of large toothed wheels, in phosphoric bronze, for the gearing of their rolling mills in all cases where the shocks are severe. Experience has shown that in no case has a tooth of such a wheel been broken, and that the wear is less than half that of ordinary bronze. (See, for further particulars concerning this special application, and also on the use of phosphoric bronze for transmission shafts for rolling mills, a note published in the "Bulletin du Musé de l'Industrie" of Belgium.)

In the February number of *Engineering* for 1873, an article was published on the use of phosphoric bronze for tuyeres, showing that such tuyeres are much superior to those in ordinary bronze, and that after a year's service they show neither fissure nor incrustations of slag or cinder. These tuyeres, already largely used in Germany, are now being tried both in England and in France.

The great resistance of phosphoric bronze has led to its use for the manufacture of cylinders both for steam fire engines and for hydraulic presses. Messrs. Merryweather have applied it to the first of these purposes, as may be seen in all the fire-engines sent by them to the Exhibition at Vienna. Messrs. McKean & Co. have also employed it in the construction of the apparatus they have made for the boring of the St. Gothard tunnel. The great elasticity of phosphoric bronze, and its easy friction on iron, have been very successfully taken advantage of in the construction of packing rings for steam pistons.

Phosphoric bronze may be drawn out into wire, and by this process it acquires a resistance at least equal to that of any other metal capable of being drawn into wire. The following table gives the results of trials made at Mr. Kirkaldy's of such wire:—

Metals.	Pulling Stress per Square Inch		Number of Twists in Five Inches of Wire.		Ultimate extension in per cent.
	As drawn. lbs.	Annealed. lbs.	As drawn.	Annealed.	
Phos. Bronze	102·750	49·351	6·7	87·0	37·5
"	120·957	47·787	22·3	52·0	34·1
"	120·950	53·381	13·0	124·0	42·4
"	139·141	54·153	17·3	53·0	44·9
"	159·915	58·853	13·3	66·0	46·6
"	151·119	64·569	15·8	60·0	42·8
Copper	63·122	37·002	86·7	96·0	34·1
Steel	120·976	74·637	22·4	79·0	10·9
Best Char. Iron	65·834	46·160	48·0	87.0	28·0

Besides its high absolute and elastic resistance, phosphoric bronze possesses in common with all alloys, where copper predominates, the advantage of not becoming crystalline, as is the case with steel and iron, under repeated concussions. It is, therefore, well adapted for the manufacture of mining and other ropes. The prime cost is higher than the ordinary material, but it is probable that the cost in the long run will be less, as, whilst resisting atmospheric and corrosive influences, it preserves, when worn out, its intrinsic value.

Phosphoric bronze of a suitable composition can be perfectly rolled and hammered. In Russia, several millions of cartridges have been made of this metal, and have been shown to bear firing as often as 120 times in succession, without being torn or otherwise injured.

As sheathing, it resists the action of sea water much better than copper. The following table gives the comparative result of six months of action of sea water on rolled phosphoric bronze on the one hand, and of yellow sheathing metal on the other, the surfaces acted upon being equal in size.

Metal.	Wt. before Immersions. Kilogs.	Wt. after Immersions. Kilogs.	Loss. Kilogs.	Per Cent.
Sheathing Metal	33·825	32·805	1·020	3·015
"	40·413	39·160	1·253	3·100
Phos. Bronze	31·615	31·260	0·355	1·123
"	51·970	51·350	0·620	1·193

A similar trial, made for the purpose of ascertaining the difference of resistance to the action of an acid solution between rolled phosphoric bronze and copper, showed for three months action of sulphuric acid marking 10 degs. Baumé, at the atmospheric temperature, a loss of 4·15 per cent. in the copper, and of only 2·3 per cent. in the phosphoric bronze.

Trials have been made by several governments in regard to the use of phosphoric bronze for artillery purposes. In every one of these trials, the resistance (toughness) of the alloy has proved superior to that of ordinary gun-metal, and it is only at this point of view, which alone interests its industrial applications, that we refer to these trials in the present paper. In Belgium, at comparative trials made with bursting charges, the ordinary bronze gun burst explosively at the second round with 1250 grms. of powder, and a projectile of 8518 grms., while the phosphoric bronze gun resisted this charge perfectly, the normal charge being 500 grms. of powder and a shot of 3,000 grms. In France, at the comparative trials with bursting charges, the ordinary bronze gun burst explosively at the second round with 1500 grms. of powder, and a projectile of 16,060 grms., whilst the phosphoric bronze gun, after firing five rounds with a similar charge, burst only at the second round, with a charge of 1750 grms. of powder and a projectile of 20,000 grms.; the cylinder had, however, got jammed into the gun. The normal charge was 550 grms. of powder and a shot of 4000 grms. In Prussia, the comparative trials were made by firing constantly normal charges, and turning off a certain thickness of

metal in the chamber after each fifty rounds. It was found that the dimensions of the phosphoric bronze guns were only altered by the firing, when the thickness of the metal had been brought down below that adopted for steel guns of the same calibre.

The Belgian government has accepted the phosphoric bronze for the manufacture of the box of the Clomblain Rifles, and for the harness buckles of the cavalry.

At the present time, besides the works at the Valbenoit, near Liége, three companies are in existence for the manufacture of phosphoric bronze, namely, Messrs. G. Höper & Co., at Iserlohn, in Germany; the Phosphoric Bronze Company, at Pittsburg, in the United States; and the Phosphoric Bronze Company, Limited, 110 Cannon Street, London, in England. The latter has exhibited several of the applications of this metal at the Kensington Exhibition.—*Jour. Iron and Steel Inst.*

THE POLLUTION OF WATER.

In "Notes on Sewage," which will be found in a series of articles in the two preceding volumes of *Engineering*, numerous chemical difficulties have been mentioned in regard to what is called "sewage contamination." The determination of this in various specimens of sewage, in ordinary water supply, in wells, etc., is yet far from satisfactory. The most eminent chemical authorities differ not only in respect to the results they obtain, but also in the methods they employ for its determination. The matter is of the highest importance in regard to sanitary conditions, for on the weight of evidence given on either side at a trial at law or equity the pecuniary results may prove serious, and in some cases ruinous to the parties concerned. We are glad to be able to give some interesting results lately communicated to the Academy of Sciences at Paris, which promise, to some extent, a solution of the difficulties which the problem presents.

There are chiefly two tests by which the sanitary character of water, either of the ordinary supply of wells, or of the effluent of a sewage farm, or the chemical treatment of sewage, may be estimated, viz., that of the physiological effects, and that by chemical analysis. The physiological method is that which is evidenced by the production of a certain class of diseases of the typhoid form from the use of impure water, of which instances are too familiar to require description. They exist in almost every large town; and, in fact, show the necessity of instant action for their prevention. But the physiological test is only of use as an indication of evil. It is, therefore, essentially followed by the chemical examination which, as we have just stated, is at once difficult and uncertain.

Careful observation, however, has shown that all the diseases of the kind to which we have referred, are invariably associated with the presence of decomposing bodies containing nitrogen, either in the water supply or sewage. The source of this nitrogen is, for all practical purposes, as invariably derived from the refuse of animal existence. This nitrogenous refuse is composed of nitrogen, hydrogen, carbon, and oxygen. The ultimate products of the decomposition of such refuse are ammonia, carbonic acid, nitrates, and nitrites. Now these latter are all harmless *per se*. It is at the intermediate stage—that is, the conversion of the refuse into these products—that danger arises to the animal system. But the presence of sulphur adds another element of danger, for by its respective combinations with hydrogen (sulphuretted hydrogen) and with nitrogen and hydrogen (sulphide of ammonium), the two most dangerous gases which we have here named in brackets, as products, are afforded. But for our present purpose we entirely omit the consideration of the sulphur compounds.

It is evident, therefore, that if the chemist detect ammonia, nitrates, and nitrites in any water, he *may* conclude that animal nitrogenous matter has been the cause of their production. As a rule this conclusion is invariably arrived at, as will be seen in the weekly or other reports of water-examiners, medical officers of health of our large towns. But as will be presently seen, other causes of the presence of ammonia exist, utterly unconnected with the animal nitrogenous refuse. It is this point to which we wish to draw special attention in the present article.

In England and France numerous instances have occurred in which gas-works have been blamed for rendering water impure. In France actions have been brought and damages obtained against the companies who have been charged with injuring wells, etc., by the infiltration of water from their works. M. Boussingault has recently presented a paper to the Academy of Sciences, in which the experiment and results obtained by M. Musculus are fully detailed. Aware of the difficulty of the subject that chemist endeavored to find a test by which the injury to well or other water could be distinguished as caused by sewage or gas waste, and his plan may be briefly explained as follows:—

In examining water thus rendered impure he supposes that the presence of ammonia has hitherto been the crucial test of the cause of the pollution. But sewage water invariably, if freshly produced, contains *urea*, while gas-refuse liquid contains none. If, therefore, urea be found in the liquid, it would certainly point to sewage as the source of contamination. But urea, on decomposing, produces ammonia, which is also contained in gas refuse, as above stated. He, therefore, sought for a means of detecting urea, and has succeeded in producing a kind of test-paper which seems well adapted for the purpose.

It appears from his researches that while urine is undergoing alkaline putrefaction small globules of a fermenting body are precipitated to the bottom of the vessel, and it is to these that the conversion of the urea into carbonate of ammonia is due. He pours the whole of the urine into a filter. At first the liquid filters rapidly, but gradually passes much slower. This he ascribes to the globules of ferment obstructing the pores of the filter, and remaining therein. The filter is then washed with distilled water to remove all trace of alkali, and carefully dried at a temperature of 35° to 40° C. It should be colored with a little tincture of turmeric, again dried, and then inclosed in a dry vessel to keep it from the action of moisture. The paper thus contains in its pores the globules of ferment, which are inactive so long as they are kept dry.

To use the paper as a test for urea, a piece is immersed in the suspected liquid. Small brown spots will appear if urea be present, because by the action of the ferment it is converted into ammonia, which thus shows the usual alkaline reaction on the turmeric, and as the quantity of the ammonia increases the paper will gradually become browned wherever a globule of ferment exists. It is necessary to remove all alkaline carbonates previously in the liquid by dilute sulphuric acid, or deceptive results, arising from their action, would be afforded. He has attempted to make this method a means of discovering the total amount of urea present

in a liquid. For this purpose a piece of paper is placed in it, a little tincture of litmus, and as much dilute sulphuric acid as will give the liquid the tint of the peel of an onion. The whole is to be heated for five or six hours to a temperature of 25° to 30° C. By the fermentation produced the urea will be converted into carbonate of ammonia, and hence by the usual method the amount of urea may be calculated. According to M. Musculus, the presence of uric acid, of albuminoid substances, and neutral salts, does not affect the accuracy of the results obtained.

Such is an outline of the plan proposed by that chemist. It is evident, on consideration, that it affords, so far as can be at present known, a very ready test for the cause of impurities in wells, brooks, etc., in respect to the refuse of gas-works and sewage contamination. Its great value consists in distinguishing the source of the nitrogen in the form of ammonia. We learn from the researches of Lehmann and others that an adult fed on average animal and vegetable food will void about 500 grains of urea daily; one on purely vegetable food about 348 grains; and one on purely animal food about 821 grains, falling to but 240 grains in a person using food from which nitrogen was carefully excluded. The average of urea in urine is about 14·25 parts in 1000 of the liquid.

Some very interesting points suggest themselves in this new method. Its value in distinguishing the difference between the effects of impurity arising from gas refuse and sewage, will be of great importance in jurisprudence. But as bearing on the results of various processes of treating sewage by irrigation, precipitation, or other means, it seems to open out a large field of inquiry that may be of essential service in controlling other methods of chemical analysis. The errors which we have seen in respect to the latter, as applied to effluent water of any of the existing sewage processes during the last three or four years, would hardly be credited by our readers, whether we refer to the ability of, or the mistakes which have been made by, various analysts. Perhaps M. Musculus may have put us in a new direction that may afford more satisfactory results than have been as yet attained.—*Engineering.*

NICKEL AT THE VIENNA EXPOSITION.

Since coins of nickel have been introduced into Belgium, Switzerland, and Germany as fractional currency, the demand for this metal has greatly increased, and also its price, and this cannot fail to greatly influence all other manufactures in which nickel is used as an alloy with copper and zinc, such as German silver, argentine, alfenide, and others. The price, which was about 4*s.* per pound a couple of years ago, has of late risen to 14*s.* and 15*s.*, and as the annual production of nickel is but about 500,000 lbs. in Europe, and 200,000 lbs. in America, it is not likely to recede much. England, France, Spain, and Italy showed no nickel exhibits at Vienna, although England produces a considerable quantity at Swansea and Birmingham from imported Norwegian and South American ores. Belgium owns nickel works at Val Benoit, near Leige, where Messrs. Levi and Kuntzel extract that metal from regulus, which is made at Varallo, in Piedmont, from magnetic iron pyrites, containing 1·5 to 2·5 of nickel and cobalt.

In the German section at the Vienna Exhibition we found nickel exhibited by Fleitmann and Witte, of Iserlohn, in Westphalia, and by the Victoria Nickel Works, of Naumburg, in Silesia. Both seem to smelt principally imported ores or regulus, though the first-named firm seems also to receive part of its ores from some Rhenish and Westphalian iron and lead mines. The once important nickel works of Dillenburg, in Nassau, have been stopped for some years, probably owing to the exhaustion of the ore, which was found at Nanzenbach, connected with serpentine and diabase, and contained 2 per cent. to 5 per cent. of nickel, together with some copper. A similar fate seems to have befallen the nickel works of Gladenbach, Grand Duchy of Hesse, where nickel ores were extracted from small lodes in Permian rocks. In the Grand Duchy of Baden nickel ores are found at St Blasien and Totmoos, these consisting of magnetic iron pyrites with some copper pyrites, and containing 2·5 to 5·5, and even 12 per cent. of metal. The ore is found in hornblende gneiss, and connected with rocks of gabbro and serpentine; it is smelted at St. Blasien in blast furnaces, into a regulus, which is call cined, remelted, and at last refined, so as to yield metacontaining 60 to 63 per cent. of nickel, 24 to 27 per per cent. of copper, and only 0·3. to 0·5 per cent. of iron. This regulus is sold to the Victoria Works of Naumburg. These works made a very good show of metallic nickel in cubes, and of sulphate of copper, at the Exhibition, and of late they have made themselves independent for raw materials by buying the Sagmyra nickel mines in Sweden. The Mansfeld Copper and Silver Company, and the Goslar Smelting Works, produce likewise a small quantity of alloys of nickel and copper, and of nickel, iron, and arsenic. The greatest producers of nickel in Germany, however, are the Saxon Cobalt Company of Oberschlema and Pfannenstiel, near Schneeberg, in the Saxon Erzgebirge. Their annual production is over 10,000 lbs. of pure metal. The clay-slate and mica-schist district, near Schneeberg, Lindeman, Zschorlau, and Neustadt, contains over 150 lodes, which yield nickel, cobalt, bismuth, and arsenic within a zone of six miles in length and about two miles in width. The mines and works date from 1642, and employ at present over 1200 miners and smelters, while connected with them are the cobalt and nickel works of Modum in the south of Norway, from whence nickel and cobalt regulus are sent to Saxony for refining. The Saxon Cobalt Company exhibited very good samples of cubes and sheets of nickel.

Looking next to Austria, we found, in the Duchy of Salzburg, the Leogang Nickel and Cobalt Company, which produce ores of nickel, cobalt, and antimony from irregular metallic deposits in clay slate. The ore is hand-picked, smelted in a blast furnace, and the regulus obtained is refined in a reverberatory furnace for a kind of white metal, or "speiss," containing 28 per cent. of nickel, 14 per cent. of cobalt, 6 to 8 per cent. of copper, and the rest iron, sulphur, and antimony. Flora von Flechner-Gersdorf, of Schladming, in Styria, likewise exhibited nickel ore, consisting of arsenide of nickel from the mines at Zinkwand and Vettern. The mica-schist here contains strata, 2 to 8 fathoms thick, which are impregnated with pyrites and other metallic ores, and intersected by lodes which are metalliferous within these metallic zones or strata, and contain ores of cobalt, nickel, arsenic, fahlerz and others.

From Hungary we found exhibits by the Kolba Metallic Mine Company, of Libthen, which produce annually abont 300 tons of ores containing from 16 to 20 per cent. of nickel, 4 to 8 per cent. of cobalt, and some copper. The richest ores are sold to Evans, Atkins & Co., of Birmingham, and the poorer stuff smelted for white metal before going to the market. The Zemberg

Nickel Company, of Dobschau, in the north of Hungary, produce some 400 to 500 tons of nickel and cobalt ore at their mines, Altenberg and Zinnberg. The strata of greywacke there inclose a large bunch of spathic iron ore, viz., carbonate of iron, which contains occasionally nickel and cobalt ores in contact with the inclosing rock. Underlying the iron ore are dioritic slates, which are traversed by numerous lodes and branch lodes, of which the Maria lode is the principal. They are composed of a black bituminous shale, which contains short, but rich, floors of nickel pyrites, together with fahlerz, arsenical pyrites, spathic iron ore, and ankerite. The richer class of ores contains about 17 per cent. of nickel and 5 per cent. of cobalt, and is sold in England.

In the Swedish Department we found nickel ore, nickel, copper, and metallic nickel, exhibited by G. Berg, from Warby and Westervik. The principal nickel works, however, are at Klefva, in Jonkoping-Lan, and at Sagmyra, Kopparberg-Lan, where magnetic iron pyrites is found in connection with gabbro and serpentine in metamorphic gneiss. In 1871 their produce was 36,800 lbs. of nickel copper, and 673,000 lbs. of nickel regulus, with about 50 per cent. of nickel and cobalt, 30 per cent. of copper, and 8 per cent. of iron. Almost the whole produce is sold to Berlin and Birmingham, where the metal is refined. In Norway there were, in 1870, 10 nickel mines, which employed about 140 men and yielded 88,000 cwt. of raw ore, this consisting of magnetic iron pyrites with 1·5 to 3, sometimes 5 to 7 per cent. of nickel. The largest works are at Skjaerdalen and Evje, in Ringerige in the south of Norway, belonging to the Ringerige Nickel Company, and at Bamble, near Kragero on the south coast, belonging to Johan Dahll. From both works we found at Vienna very complete exhibits. The raw ore is first calcined in large heaps, and then smelted in a blast furnace with coke, in order to obtain a regulus with about 15 to 17 per cent. of nickel. This is again roasted in kilns, and smelted for a second regulus with about 30 to 35 per cent. of nickel, which is then remelted with coke in an open hearth under the oxidizing influence of a strong blast, when nearly the whole of the iron and part of the sulphur are oxidized, and an alloy containing 50 to 60 per cent. of nickel, 25 to 30 per cent. of copper, and 24 to 26 per cent. of sulphur is obtained.

In the American Section we found the very interesting exhibits of Joseph Wharton, of Philadelphia, who showed nickel and cobalt ores, including fine samples of fibrous millerite, from the Gap mine, in Pennsylvania, which seems to be a neighbor of the celebrated mine La Motte, Mo., and which contains a lode five feet thick, yielding ores of nickel, cobalt, copper, and lead. There were also samples of nickel regulus and metallic nickel, alloys of half copper and half nickel, and metallic nickel in cubes, shot, and in plates, which latter are employed as electrodes in electro-plating. This process is largely carried out by the Keith Nickel Plating Company of New York, which employs the process of Professor Bottger, of Frankfort, who was the first to use a solution of sulphate or chloride of nickel-ammonium, from which the coating is deposited upon other metals by the action of a galvanic battery. South America, where rich ores of nickel are found in Peru and Brazil, exhibited nothing at Vienna.—*Engineering.*

OPENING ADDRESS.

BY PROF. A. CRUM BROWN, M.D., F.R.S.E., F.C.S.,

President of the Chemical Section of the British Association for the Advance of Science.

One hundred years have elapsed since the discovery of oxygen by Priestley. Perhaps we should say rediscovery, for there is no doubt that about one hundred years earlier Mayow prepared from nitre nearly pure oxygen, and observed and recorded some of its most marked properties. Mayow's discovery, however, led to nothing, while Priestley's was the most important step in that reconstruction of speculative chemistry which was commenced by Black, and carried on with surprising energy and thoroughness by Lavoisier and his associates. I shall not detain you by enumerating the ways in which this discovery has affected chemistry, both practical and speculative. The pre-eminent position to which oxygen was at once elevated, and which it so long retained, makes this altogether unnecessary. I wish, however, to point out one character of the phlogistic controversy which sharply distinguishes it from many others. The truth represented by the theory of phlogiston was not recognized with sufficient distinctness by the supporters of that theory to give them any chance of success in opposition to a band of devoted adherents of a view which was clearly understood by all. The phlogistists were completely defeated, and the theory ceased to exist. It has been left for chemical antiquaries to pick out, with difficulty and uncertainty, a meaning from the ruins.

I have mentioned this character, because I wish to draw your attention to another more recent controversy, the result of which was very different.

The questions as to chemical constitution raised about forty years ago by Dumas and the new French school, in opposition to Berzelius, may now be said to be practically settled. The great majority of chemists are agreed as to what is to be understood by chemical constitution, and also as to the nature and amount of evidence required in order to determine the constitution of a substance. How has this agreement been produced? Some historical writers seem to wish us to believe that it is the result of the triumph of the ideas of Dumas, Gerhardt, and Laurent, and the defeat of the dualistic radical theory of Berzelius; that the arguments of Berzelius and his followers were only useful as giving occasion for a more full and convincing proof of the unitary substitution theory than would otherwise have been called for; that, in fact, the adherents of dualism played the part (not unfrequently supposed to be that of the conservative party in politics) of checking and criticizing the successive developments of truth, and thus allowing them time to ripen.

In opposition to the view thus broadly stated, I would place another, and for the sake of contrast shall state it also in perhaps too broad a form: that the two theories, the dualistic radical theory and the unitary substitution theory, were both true and both imperfect; that they underwent gradual development, scarcely influenced by each other, until they have come to be almost identical in reference to points where they at one time seemed most opposed.

I have said that the development of the one theory was scarcely influenced by that of the other. Of course the *facts* discovered by both parties were common property, and the development of both theories depended upon the discovery of these facts; but the explanation of facts and the reasoning from them given

by each party seemed to the other scarcely worthy of serious consideration, and were treated as matter of ridicule. And the habit of mind created by this mode of viewing the opposed theory rendered it difficult for those who were engaged in the controversy on either side to see how nearly the two theories have now come to coincidence. Their language still remains different; but as the facts are the same for both, it is not difficult for a neutral critic to translate from the one to the other; and if we do so we shall see that there is much real agreement between the two modes of representing chemical ideas, historically derived, the one from Berzelius, the other from Dumas, Laurent, and Gerhardt.

In both, chemical constitution is regarded as *the order in which the constituents are united in the compound;* and the same fundamental notion is indicated in the one by reference to proximate constituents, in the other by the concatenation of atoms. To show that this is so, and that the fundamental notion can be arrived at from the dualistic as well as from the unitary starting point, I shall cite an illustrative case. Every student of chemical history will remember the view of the constitution of trichloracetic acid propounded by Berzelius, and afterwards supplemented by a similar view of the constitution of acetic acid, and an explanation of the likeness of some of the properties of these two substances. This has sometimes been spoken of as a subterfuge of a not very creditable kind, by means of which Berzelius apparently saved his consistency while really yielding to the arguments of his opponents. But if, instead of looking at it in the light of the substitution controversy, we consider it in itself as a contribution to speculative chemistry, we at once recognize in it a statement, in Berzelian language, of the views we now hold as to the constitution of these acids. The view was, that acetic acid is a compound of oxalic acid and methyl, trichloracetic acid a compound of oxalic acid and the sesquichloride of carbon. They differ considerably from each other, because the "copulæ" (methyl and sesquichloride of carbon respectively) are different; but their resemblance is strongly marked, because they contain the same active constituent, oxalic acid; and most of the prominent characters of the substances depend upon it, and not upon the copulæ. Let us first free this statement from what we may call archaisms of language. It will then assume something like the following form: the carbon in acetic acid is equally divided between two proximate constituents, one of which is an oxide, the other a hydride of carbon. Trichloracetic acid similarly contains an oxide and a chloride of carbon, between which the carbon is equally divided. The oxide is the same in both acids, and is that oxide which occurs in oxalic acid. The hydride and the chloride have the composition of the substances, the formulæ of which are C_2H_6 and C_2Cl_6 respectively. Oxalic acid undergoes chemical change much more readily than the corresponding hydride or chloride; and therefore the chemical character of acetic and of trichloracetic acids depends much more on the oxidized than on the other constituent, and they thus have a marked resemblance. The oxidized constituent is united to the other in a manner different from that in which oxalic acid is united to bases in the oxalates, inasmuch as, while the basic water of hydrated oxalic acid is displaced when oxalic acid unites with a base, in hydrated acetic and trichloracetic acids there is the same proportion between the basic water and the oxidized carbon as there is in oxalic acid.

Now, has not this a great resemblance to the view entertained by most modern chemists, that acetic acid is a compound of the radical carboxyl (half a molecule of oxalic acid) and the radical methyl (half a molecule of methyl gas), that trichloracetic acid similarly contains the same radical carboxyl and the radical CCl_3, and that the prominent chemical properties of these bodies depend upon their containing carboxyl, and that they therefore resemble each other?

The modern view contains nothing inconsistent with that of Berzelius; but it no doubt contains something more; it contains an explanation of the difference between the manner in which carboxyl is united to methyl in acetic acid, and the manner in which oxalic acid is united to bases in the oxalates. But it will surely be admitted that Berzelius was here far ahead of his opponents—so far ahead, that they altogether failed to see his meaning, and looked upon his argument as a clumsy device.

The treatment by Berzelius of the constitution of the sulpho-acids furnishes a precisely similar case. These are now regarded as compounds of the radical SO_2OH (which we may call sulphoxyl). This radical is half a molecule of hyposulphuric acid, and Berzelius considered them coupled compounds of hyposulphuric acid, adopting at once the view first brought forward by Kolbe in his classical memoir on the sulphite of perchloride of carbon and the acids derived from it.

I might pursue the history of the carbon and sulpho-acids further, and trace the development of the theory of their constitution through the discoveries of Kolbe, and his beautiful application to the cases of carbon and sulphur, of Frankland's far-sighted speculation on the constitution of the organo-metallic bodies, pointing out the relation of Kolbe's views of the constitution of acids, alcohols, aldehydes, and ketones, to the Berzelian theory on the one hand, and to the opinions of modern chemists on the other; but the greater part of such an historical sketch has been given very recently by Kolbe himself in the *Journal für Praktische Chemie*, and I may therefore omit it.

It would be easy to bring forward cases to show that our present views can be directly derived from the substitution theory and the types of Dumas and Gerhardt, through the complications of multiple and mixed types, and the labyrinthine formulæ to which these gave rise, to the wonderfully simple and comprehensive system of Kekulé; but that is unnecessary, as this development has been fully and ably described by more than one thoroughly competent writer.

We have been discussing a case in which Berzelius was right in considering a compound of carbon, oxygen, and chlorine as composed of two parts—an oxide and a chloride of carbon. It is only just that we should only take some notice of cases, at first sight similar, in which modern chemists would be inclined to think that he was wrong. This is the more necessary, as an examination of these cases will enable us to see what was the really valuable contribution made to speculative chemistry by the substitution theory.

Compounds containing three elements were formulated in two different ways by Berzelius:—

1. One of the elements was represented as combined with a radical composed of the other two, as—hydrocyanic acid, $H_2{\cdot}C_2N_2$; ether, $C_4H_{10}{\cdot}O$.

2. The ternary compound was represented as composed of two binary compounds, having one element common, as—caustic potash, KO,HO; chromochloric acid, $2CrO_3,CrCl_6$.

Phosgene gas was at first formulated in the former of

these ways as CO,Cl_2; but latterly he was forced, in consistency, to give up all radicals containing oxygen or other strongly electro-negative element,* and to write the formula of phosgene gas CO_2,CCl_4. Similarly, in every case where a positive element or radical is combined with two negative elements or radicals, he represented the compound as composed of two binary compounds, thus—chloride of acetyl, $2C_4H_6O_3.C_4H_6Cl_6$, as a compound of acetic acid and the corresponding terchloride.

This was in perfect consistency with the mode in which ternary compounds, containing one negative and two positive elements or radicals were formulated, as caustic potash, KO,HO, sulphate of copper, CuO,SO_3, etc.; but it lacks the practical justification which can be given for the formula C_2H_6,C_2O_3 for acetic acid; for phosgene acts readily on water, forming carbonic and hydrochloric acids, an action which does not take place with perchloride of carbon; and it is not easy to see why the latter substance should be more readily attacked by water when combined with carbonic acid than when free. This difference did not escape the attention of Berzelius, and led him to distinguish two modes of chemical union: (1) where the constituents were held together by the electro-chemical force, and wholly or partially neutralized each other, as in the oxygen and sulphur salts; and (2) where a so-called "copula" was attached by an unknown force to a substance, without greatly modifying its chemical activity. The distinction seems arbitrary; but it was not, as is usually supposed, a mere artificial bulwark to protect the electro-chemical theory; it has a real and very important meaning, a meaning which the development of the substitution theory enables us to explain.

The phenomena of electrolysis, upon which the Berzelian system is based, bring forward into great prominence *one* of the chemical units, viz., the *equivalent;* and the pre-eminent position of oxygen as the most electro-negative element, made it most natural to select the atom of oxygen as the standard of equivalence, so that an equivalent of any element or radical was defined as that quantity of it which is equivalent to one atom of oxygen. Gay-Lussac's law of gaseous volumes, which was adopted by Berzelius, and which, by a curious accident, happens to be true for all elements gaseous at ordinary temperatures, led to the formulæ H_2 and Cl_2 for the *equivalents* of hydrogen and chlorine; but although these formulæ explicitly indicate the divisibility of the equivalents of these elements, this divisibility was not recognized, and integral numbers of equivalents were alone tolerated. Thus hydrochloric acid was written H_2Cl_2, ammonia N_2H_6, etc., and the etymological meaning of the word atom was soon lost. The use of barred letters to indicate two atoms or one equivalent of such elements as hydrogen and chlorine, further contributed to hide the important fact of their divisibility.

The first great result of the substitution theory was to change the unit of equivalence, and to take as the standard the atom of hydrogen or of chlorine instead of that of oxygen; and although it would be most unjust to forget the services of Dumas, Gerhardt, Laurent, and Odling in this matter, the credit of removing the bars from H, Cl, and their comrades, and allowing the hitherto chained partners to walk at liberty, undoubtedly belongs mainly to our distinguished colleague and master, Prof. Williamson.

* In 1838 Berzelius was inclined to regard C_2O_2, to which he gave the name "oxatyl," as the radical of oxalic acid and oxamide.

The establishment of the water type, or (to put it in another form) the proof that the atom of oxygen contains two units of oxygen, inseparably united but capable of separate action, led the way to the explanation of all the difficulties which beset the theory of radicals and copulæ. It at once explained how two oxides or two sulphides united together;* and the idea of "polybasic," or, as we should now say, polyad atoms and radicals, was soon used to explain the existence of polybasic acids, double salts, acichlorides, and many other kinds of ternary compounds.

But a fact does not cease to exist because it is explained. Quicklime and water unite together, although we can now explain how they do so; and a useful purpose may still be served by the enumeration, as in the old dualistic formulæ, of the pairs of united equivalents. Although some of these equivalents belong to the same atoms, it is nevertheless true that they are united in pairs. Caustic potash might thus be formulated, $KO_{\frac{1}{2}}$, $HO_{\frac{1}{2}}$, or $\frac{1}{2}(K_2O.H_2O)$; phosgene gas, $\frac{1}{2}(CO_2,CCl_4)$; and chlorochromic acid, $\frac{1}{3}(2CrO_3,CrCl_6)$. These formulæ are not so well suited for general use as those now current; but the consideration of them as accurate representations of facts may enable us to see that the copulæ of Berzelius had a real and valuable meaning. Take, for instance, the formula of acetic acid, $H_3C—CO—OH$, or $\frac{3}{4}CH_4,\frac{3}{4}CO_2,\frac{1}{2}H_2O,\frac{1}{4}C_2$; it is this last term which indicates the coupled character of the compound. If we look upon acetic acid as a compound of carbon, it is a coupled compound because all the equivalents of carbon in it do not belong to the same atom, and the two atoms of carbon are directly united together, and replacement of the equivalents united to one of these atoms does not very greatly affect the function or chemical character of the equivalents united to the other.

I have, perhaps, spent too much of your time upon these historical questions. Let us now shortly consider what is the present state of our knowledge as to chemical constitution. This I have already defined as the order in which the constituents are united in the compound. We may, indeed, use metaphorical language, and speak of the relative position of atoms, perhaps deluding ourselves into the notion that such language is more than metaphorical; but the phenomena of combination and decomposition, although we cannot doubt that they depend solely upon the relative position and dynamical relations of the atoms, are not alone sufficient to prove even that atoms exist. Our knowledge of the intimate structure of matter comes from another source—from the study of the properties rather than of the changes of substances, and of the transformations of energy which accompany the transformations of matter.

This is strictly a branch of chemistry; the aim of chemistry is to connect the properties of substances and the changes they undergo with their composition, taking this word in its widest sense; and we must not allow our friends in Section A to cut our science in two and appropriate the half of it. We all frankly admit that chemistry is a branch of physics: but it is so as a whole—no section of it is more purely physical than all the rest. To accept a narrower definition of chemistry is to reduce ourselves to the position which the collector occupies among naturalists; it is to admit that it is our business to provide part of the materials out of which a science in which we have no share may be constructed

* It does not explain the existence of double chlorides, bromides, etc. These compounds, apparently so similar to the double oxides and sulphides, are still unexplained.

by others. But we need not fear that this so-called physical side of chemistry will ever be divorced from the study of chemical change. The names of Faraday and Graham among those who have left us, of Andrews among those who are still at work, are sufficient proof of this; and a study of their researches will conclusively show that great results can be looked for in this direction only from a physicist who is also a chemist.

There are three special directions in which such investigations have already influenced chemical theory: 1. *Electrolysis*, which has confirmed the equivalent as a chemical unit, has proved that equivalents unite in pairs, thus forming the basis of electro-chemical theory, and has shown us how to estimate the amount of energy involved in the union of a given pair of equivalents. 2. *Vapor-density*, from which Avogadro inferred the law of molecular volumes (since proved by Clerk-Maxwell), which has given us the molecule as a chemical unit, and formed the basis of the unitary theory. 3. *Specific heat*, from which Dulong and Petit inferred their empirical law, which gives us the most satisfactory physical definition of the atom as a chemical unit.

We naturally turn to the future, and try to guess whence the next great revolution will come. For although periods of quiet have their use, as affording time for filling up the blank schedules furnished by the last speculative change, such periods have seldom been long, and each has been shorter than its predecessor.

But it is impossible to make a certain forecast; looking back, we see a logical sequence in the history of chemical speculation; and no doubt the next step will appear, after it has been taken, to follow as naturally from the present position. One thing we can distinctly see—we are struggling towards a theory of chemistry. Such a theory we do not possess. What we are sometimes pleased to dignify with that name is a collection of generalizations of various degrees of imperfection. We cannot attain to a real theory of chemistry until we are able to connect the science by some hypothesis with the general theory of dynamics. No attempt of this kind has hitherto been made; and it is difficult to see how any such attempt can be made until we know something in reference to the absolute size, mass, and shape of molecules and atoms, the position of the atoms in the molecule, and the nature of the forces acting upon them. Whence can we look for such knowledge?

The phenomena of gaseous diffusion, of gaseous friction, and of the propagation of heat through gases, have already given us an approximation to the size and mass of the molecules of gases. It is not unreasonable to suppose that a comparative study of the specific heat of gases and vapors may lead to some approximate knowledge as to the shape of their molecules; and a comparison of such approximate results with the chemical constitution of the substance may lead to an hypothesis which will lay the foundation of a real theory of chemistry.

Chemistry will then become a branch of applied mathematics; but it will not cease to be an experimental science. Mathematics may enable us retrospectively to justify results obtained by experiment, may point out useful lines of research, and even sometimes predict entirely novel discoveries, but will not revolutionize our laboratories. Mathematical will not replace chemical analysis.

We do not know when the change will take place, or whether it will be gradual or sudden; but no one who believes in the progress of human knowledge and in the consistency of nature can doubt that ultimately the theory of chemistry and of all other physical sciences will be absorbed into the one theory of dynamics.—*Nature.*

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS.

In the preparation of these abstracts the Editors are assisted by the following chemists:—

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Berichte der Deutschen Chemischen Gesellschaft zu Berlin.

No. 6. 1874.

On some derivatives of **β-dinitrophenol.**—H. Salkowski and G. Rebs.—The substances prepared were β-dinitroanisol, $C_6H_3(NO_2)_2OCH_3$; β-dinitrophenetol, $C_6H_3(NO_2)_2OC_2H_5$; β-dinitroanilin, $C_6H_3(NO_2)_2NH_2$; and from β-dinitroanilin was obtained dinitrobenzol and trinitrobenzol.

On the constitution of **dinitrobenzol.**—H. Salkowski.—It is shown that dinitrobenzol is not a para (1 : 4) derivative. It is probably a member of the meta (1 : 3) series.

Antimonic chloride as a reagent for **cæsium salts.**—R. Godeffroy.—When a solution of antimonic chloride in concentrated chlorhydric acid is added to a solution of a cæsium salt, a precipitate is formed of the formula $SbCl_3CsCl$. The other alkalies give no similar precipitate.

Protamine, a new organic base from the spermatozoids of Rhine salmon.—F. Miescher.—The base has the formula $C_9H_{21}N_5O_3$. The properties are not very striking.

On the **heat of combination** of the oxides of nitrogen.—Julius Thomsen.—The results recently obtained by Berthelot are almost identical with those already published by the author. The methods adopted by the two investigators in making their determinations were entirely different.

On **thiobenzol and thioanilin.**—F. Krafft.—If the NH_2 group is removed from thioanilin, a substance is obtained that is identical with phenyl sulphide. If the NH_2 group is introduced into phenyl sulphide, thioanilin is obtained.

On **aromatic silicium-compounds.**—A. Ladenburg.—The following reaction was realized:—

$$2SiC_6H_5Cl_3 + 3Zn(C_2H_5)_2 = 2SiC_6H_5(C_2H_5)_3 + 3ZnCl_2.$$

By the action of chlorine upon the silicium phenyltri-

ethyl thus obtained, there is produced a chlorinated product $SiC_{12}H_{19}Cl$. By the action of $SiCl_4$ on mercurytolyl a substance of the formula $SiC_7H_7Cl_3$ was obtained.

On **arsenic-molybdenic acid compounds.**—Hermann Seyberth —When a solution of molybdenic acid and arsenic acid in the presence of an ammonia salt is heated to boiling for a long time, a precipitate is deposited of the formula $As_2Mo_7O_{29}H_6(NH_3)_2+4H_2O$. This is soluble in hot water, and gives precipitates with silver and barium solutions: $As_2Mo_7O_{29}Ba_3$, and $As_2Mo_7O_{29}Ag_6$. The free acid has the formula $As_2Mo_7O_{29}H_6+11H_2O$.

On **isethionic amide.**—Hermann Seyberth.—The amide of isethionic acid was prepared by heating ammonic isethionate. It is not identical with taurine.

On **guanoralite,** a new mineral in the birds' eggs of Peru guano.—F. Wibel.—The mineral has the formula—

$$(H_4N)_2SO_4+2K_2SO_4+3KHSO_4+4Aq\left.\begin{matrix}K_7\\(H_4N)_2\\H_3\end{matrix}\right\}(SO_4)_6+4Aq.$$

On a method of formation of **diphenylene oxide.**—C. Graebe.—The method consists in heating phenol-lead:—

$$(C_6H_5O)_2Pb=\left.\begin{matrix}C_6H_4\\|\\C_6H_4\end{matrix}\right\}O+Pb+H_2O.$$

On the action of **lead oxide on phenol at high temperatures.**—Arno Behr and W. A. Van Dorp.—The authors obtained diphenylene oxide according to the reaction mentioned in the preceding notice. A second substance was obtained of the formula $C_{13}H_8O_2$.

On **dibrom- and dioxymalonic acids.**—W. Petrieff.—Dibrommalonic acid was obtained by dissolving bromine and malonic acid in proper quantities in chloroform. From the dibrominated acid the dioxy acid was obtained by dissolving the barium salt in HCl, and evaporating almost to dryness.

Miscellaneous Communications from the Laboratory of the London Institution.—Henry E. Armstrong.—

I. On the preparation of haloid-derivatives of **nitrophenol sulphuric acids.**

II. **Bromphenol from bromanilin.**—The transformation was effected by Griess' method. The bromphenol obtained was treated with nitric acid, and thus a bromdinitrophenol was formed, which was identical with the product of the action of bromine on α-dinitrophenol.

III. On **cresole from coal-tar.**

IV. On the action of **sodic formate on potassic disulphobenzolate.**—No dicarbonic acid was obtained.

V. On **naphthyl sulphides.**—By heating the potassium salts of α- and β-naphthalinsulphuric acids with potassic sulphocyanate, two naphthyl sulphides, $\left.\begin{matrix}C_{10}H_7\\C_{10}H_7\end{matrix}\right\}S$, were obtained.

Peculiar occurrence of **humic acid.**—Th. Lettenmayer and C. Liebermann.—The acid was found in combination with NH_3,K,Na as a brittle resinous coating on a beech tree.

On the addition-products of **hypochlorous acid with allyl-compounds.**—Louis Henry.—Author has previously shown: 1. That hypochlorous acid combines with allyl-compounds. 2. That to one molecule of an allyl-compound one molecule (OH)Cl can be bound. 3. That the product of this reaction is a chlorhydrine of a glycerine compound $(C_3H_5)X(OH)Cl$. From these facts he argues that the commonly accepted formula for allyl-compounds, viz., $\begin{matrix}CH_2X\\|\\CH\\\|\\CH_2\end{matrix}$ is correct. He further states, as a result of his investigation, that, whenever a molecular system XX_1, formed of simple or compound radicals of different nature and unequal energy, combines with a hydro-carbon group C_nH_m, the most negative radical X unites with that member of the carbon-chain that contains the smallest quantity of hydrogen. A direct experiment bearing upon this point was made with (OH)Cl and allyl-chloride. The result of the combination of these two substances yielded on oxidation bichlorpropionic acid: hence the product was a primary alcohol of the formula—

$\begin{matrix}CH_2Cl\\|\\CHCl\\|\\CH_2OH\end{matrix}$ The Cl has embodied with CH, and the OH with CH_2, according to the principle laid down.

Conversion of **dinitrobenzol into dibrombenzol.**—C. Wurster and U. Grubenmann.—This is a repetition of an investigation by Griess. Bromnitrobenzol was first prepared by treating acetanilide with bromine water, the bromacetanilide with nitric acid, and the bromnitroacetanilide with NaOH. The bromnitroanilin thus obtained was treated with ethyl nitrite, which yielded bromnitrobenzol. This bromnitrobenzol can also be prepared by replacing one of the NO_2 groups in dinitrobenzol by bromine. The bromnitrobenzol was now converted into bromanilin with tin and chlorhydric acid, and the bromanilin then treated with nitric acid, nitrous acid, dilute sulphuric acid, and bromine water. Thus was obtained a liquid variety of bibrombenzol identical with the meta-dibrombenzol described by V. Meyer and O. Stüber. This reaction is then a new proof of the meta-position of the groups in dinitrobenzol.

Concerning the **azo-compounds.**—W. Michler.—The biazoxybenzoic acid formerly described has been more carefully examined. Fuming nitric acid converts it into a mononitro-derivative. Tin and chlorhydric acid convert it into diamidobenzoic acid. Just as sodium-amalgam acting upon ordinary binitrobenzoic acid yields biazoxybenzoic acid, so, in acting upon the isomeric variety of binitrobenzoic, an isobiazoxybenzoic acid is produced.

On **ethylnitrolic acid.**—Victor Meyer.—The salts of ethylnitrolic acid are easily decomposable. When heated the acid undergoes the following decomposition:—

$$2C_2H_4N_2O_3=2C_2H_4O_2+NO_2+N_2.$$

Sodium-amalgam causes the following decomposition:—

$$C_2H_4N_2O_3+H_2+H_2O=C_2H_4O_2+HNO_2+NH_3.$$

Sulphuric acid decomposes the acid as follows:—

$$C_2H_4N_2O_3=C_2H_4O_2+N_2O.$$

It appears from these reactions that ethylnitrolic acid contains the acetyl-group. Hence, a probable formula is $CH_3—CO—NO_2NH$.

On **nitro-oxysulphobenzidanilide** and **diamido-oxysulphobenzide.**—J. Annaheim.—Nitro-oxysulphobenzide and anilin give a compound

$$\left.\begin{matrix}C_6H_5N\\C_6H_5N\end{matrix}\right\}\left.\begin{matrix}H\\C_6H_3NO_2\\C_6H_3NO_2\\H\end{matrix}\right\}SO_2.$$

When this is treated with iodide of phosphorus, re-

duction takes place, and a substance of the composition $\left.\begin{matrix}C_6H_3NH_2OH\\C_6H_3NH_2OH\end{matrix}\right\}SO_2\,2HI\,2H_2O$ is formed. With tin and chlorhydric acid the reduction is also easily effected. The formula of Glutz for amido-oxysulphobenzide is hence incorrect.

Concerning **orcin.**—P. Weselsky.—When nitrous acid is allowed to act upon orcin in ethereal solution, a substance is formed of the formula $C_{14}H_{11}NO_3$. When this substance is treated with concentrated hot nitric acid, a new compound is formed of the formula $C_{14}H_7N_5O_{10}$. It is probable that the latter compound resembles in structure the nitrate of the tetrazo-compound of resorcin. The formation of the first-mentioned compound is accompanied by the formation of two isomeric varieties of mononitro-orcin, both of which were isolated and analyzed. β-nitro-orcin treated with bromine yields nitrobibromorcin, $C_7H_3Br_2NO_2\left\{\begin{matrix}OH\\OH.\end{matrix}\right.$

Concerning **phloroglucin.**—Rudolf Benedikt.—By the action of nitrous acid upon phloroglucin there is formed, among other products, a coloring matter of the formula $C_{12}H_9O_5$.

On **bixin.**—Carl Etti.—The coloring matter from *bixa orellana* may be obtained in crystalline form. Author is engaged in its study.

On the synthesis of **dicyandiamidine.**—E. Baumann.—The compound may be easily obtained by fusing urea and a guanidine salt together. The reaction may be represented thus:—

$$CH_5N_3 + COH_4N_2 = C_2H_6N_4O + NH_3.$$

The constitution of dicyandiamidine must hence be

$$C\begin{matrix}=HO\\-H_2N\\\diagdown HN—CO—NH_2,\end{matrix}$$

and that of dicyandiamide

$$C\begin{matrix}=HN\\-HN\\\diagdown HN\end{matrix}\!\!>C=NH.$$

Communications from the **laboratory at Greifswald.**—H. Limpricht.—A number of salts of **metatoluidin** were prepared and are here described. Fuming sulphuric acid and metatoluidin give metamido-orthosulphotoluenic acid. This was converted into orthosulphotoluenic acid by the usual method.

On **multiples in thermo-chemical researches.**—J. Thomsen.—The author has been seeking to show that the amounts of heat evolved in analogous chemical processes are either themselves (in terms of a selected unit) multiples of a common constant, or that their differences are such multiples. He has furnished a large number of examples, and considers the principle as proved, notwithstanding the opposition of Berthelot. He refrains from drawing conclusions from the facts thus far established.

Communications from the University Laboratory at Göttingen.—H. Hübner.—

a. **Iodonitrophenoles.**—Phenol derivatives were prepared from chlorsalicylic acid, iodosalicylic acid, and nitrosalicylic acid, and the mono-nitro-compounds of these derivatives then examined. For the purpose of comparing the products thus obtained with those obtained directly from phenol, the action of iodine upon the two known mononitrophenols was studied.

b. On **isomeric benzonitranilides,** $C_6H_4NO_2NH\,C_6H_5CO$, and their different conduct towards hydrogen.—C. Stöver.—The two isomeric compounds were obtained by the action of nitric acid upon benzanilide. One variety, when treated with hydrogen, gives monobenzodiamidobenzene. The other, treated in the same way, gives the base $C_{13}H_{10}N_2$.

c. **Toluylenediaminesulphuric acid.**—J. Wiesinger.—The acid was prepared by treating toluylenediamine with fuming sulphuric acid. A number of its salts were prepared and are here described.

Contributions to our knowledge of **ita, citra, and mesaconic acids.**—G. A. Barbaglia.—An attempt was made to obtain an addition-product of itaconic acid and HCN. It was of doubtful success. Among the products obtained by heating itaconic acid with aqueous HCN was citraconic acid. Further, by heating the impure product with concentrated solution of potassa, mesaconic acid was obtained.

On the action of **chlorine on acetone.**—G. A. Barbaglia.—Two products were obtained, viz.: monochloracetone and a solid variety of dichloracetone. Author does not consider this latter substance as isomeric with the known dichloracetone, but rather a condensation product, formed by the union of two molecules of dichloracetone. He bases his belief upon specific gravity determinations.

No. 7.

Concerning **phospham.**—M. Salzmann.—Ammonia was conducted over PCl_5 in a long glass tube. The analysis of the product gave numbers that agree approximately with the formula $H_4P_2N_5$, but the author looks upon this product as a mixture of several substances.

On the action of **bromine on sodium-ethylate.**—E. Sell and M. Salzmann.—When the substances are allowed to act upon each other, molecule for molecule, the products are ethyl bromide, alcohol, ethyl acetate, and ethyl monobromacetate. If bromine is employed in excess, the principal product is $C_2H_2Br_4$, but at the same time there are formed formic acid, alcohol, and ethyl monobromacetate.

On the action of reducing agents on **nitrobenzanilide.**—C. A. Bell.—Ammonic sulphide effects the reduction which consists in a replacement of the two oxygen atoms in the nitro-group by two atoms of hydrogen, the product being—

$$C_{13}H_{12}N_2O = \left.\begin{matrix}C_6H_4.NH_2\\C_7H_5O\\H\end{matrix}\right\}N.$$

Concerning the derivatives of **sodium-acetic ether.** Wm. G. Mixter.—Just as Frankland and Duppa and Genther allowed sodium and ethyl iodide to act upon acetic ether, so the author has allowed butyl iodide and sodium to act upon the same ether. The reaction in the latter case is perfectly analogous to that in the former case. Two compounds were isolated from the product, viz.: dibutyl-ethyl aceto-acetate, $C_{14}H_{26}O_3$, and isobutyl acetone, $C_7H_{14}O$. Acetyl chloride and sodium-acetic ether, when allowed to act upon each other, yield Genther's ethyldiacetic acid.

On **brominated ethers of acetic acid.**—A. Steiner.—Bromine was caused to act upon methyl acetate in sealed tubes, and as products there were obtained $C_3Br_6O_2$ and $C_3Br_5HO_2$. Hence the bromine has simply replaced the hydrogen, and not decomposed the ether. If ethyl acetate instead of methyl acetate is employed, the principal products are ethyl bromide and dibromacetic acid.

On **dibrommethan.**—A. Steiner.—This substance was prepared by heating brommethan and bromine together in a sealed tube. At the same time bromoform is produced.

Synthesis of the ethereal oil of **cochlearia officinalis.**—A. W. Hofmann.—The formula of the oil was determined to be C_5H_9NS. It combines with ammonia, forming a crystallized compound. Treated with conc. sulphuric acid it yields a base butylamine $\left.\begin{matrix}C_4H_9\\H_2\end{matrix}\right\}N$. These facts show that the oil belongs to the class of mustard oils. Secondary butyl alcohol (methyl ethyl carbinol) yields an amine identical with that obtained from the ethereal oil above mentioned, and from this amine the oil itself, a secondary butylmustard oil, was readily prepared. The formula of the oil is hence—

$$S{=}C{=}N{-}\overset{\displaystyle CH_3}{\overset{|}{C}}{-}CH_2CH_3.$$
$$\underset{\displaystyle H}{|}$$

On **crotonyl mustard oil.**—A. W. Hofmann.—This was readily obtained from isobutyl iodide. Its formula is $\left.\begin{matrix}C_4H_7\\CS\end{matrix}\right\}N$. An amylene mustard oil $\left.\begin{matrix}C_5H_9\\CS\end{matrix}\right\}N$ was also obtained in an analogous manner.

On the **ethereal oil of tropæolum majus.**—A. W. Hofmann.—This oil is the nitrile of alphatoluic acid C_8H_7N. Treated with alkalies it yields phenylacetic acid.

On the **ethereal oil of nasturtium officinale.**—A. W. Hofmann.—This oil proved to be a homologue of the preceding oil, and the nitrile of phenylpropionic acid.

On **methylanilin.**—A. W. Hofmann.—Methylanilin was prepared in large quantities from the commercial product.

Synthesis of **aromatic monamines** by wandering of atoms in the molecule.—A. W. Hofmann.—By heating ethylanilin hydrochlorate in sealed tubes to 300°–330°, the following reaction was realized:—

$$C_6H_5.C_2H_5.HN.HCl = (C_6H_4.C_2H_5)H.HN.HCl.$$

With amylanilin a similar transformation of the secondary into the primary base was effected.

Lecture experiments.—A. W. Hofmann.—Leucanilin forms a colorless solution with water. If pure charcoal be added to such a solution, and the latter then boiled and filtered, the filtrate is of a deep red color. The oxygen contained in the pores of the charcoal causes the oxidation of the leucanilin, rosanilin being produced.

Oxidation made perceptible by the formation of colored from colorless compounds by contact with air. A moderately concentrated solution of naphthalin-red is boiled for a few minutes with zinc-dust, and thus a perfectly colorless liquid is obtained. As soon as the air is expelled from the flask by the alcohol vapor, the flask is closed by a cork. The zinc sinks to the bottom, and above it the liquid is clear and colorless. By gently shaking the flask the inside is moistened with the liquid, and, on now removing the cork, the air which enters causes the liquid to turn red and the whole flask appears of a deep red color.

Liquid phosphine.—This substance can be readily prepared without danger. It is evolved slowly from calcic phosphide and conducted through a U-tube which is inserted in a freezing mixture.

Maximum density of water.—A small glass sphere is so constructed that it just floats in distilled water of + 4° C. If the sphere is placed in a vessel containing water at 0°, it sinks, and the same is true if the water in the second vessel has the ordinary temperature.

Sodium-press.—Description of a small press, the object of which is to press sodium into wire. By this means the character of the alkali-metals can be clearly shown.

Reversed Leidenfrost's experiments.—A small ellipsoid of silver is heated to redness and then dipped in a beaker full of water. At first there is no sound heard, and for five or six seconds the silver remains visibly red hot under the surface of the water. Suddenly there occurs a violent explosion, which sends the water in every direction, and usually breaks the beaker.

Further observations on the unlike conduct of **isomeric nitramines** under the influence of the alkalies.—Paul Wagner.—Dinitrotoluidin when boiled with caustic soda yields dinitrocresole. Dinitroacettoluid treated in the same manner is decomposed, yielding complex products. Mononitroacettoluid boiled with caustic soda yields mononitrocresole.

Bromnitronaphthol.—R. Biedermann and L. Remmers.—When brommononitroacetonaphthylamine—

$$N\left\{\begin{matrix}C_{10}H_6Br(NO_2)\\C_2H_3O,\\H\end{matrix}\right.$$

is boiled with concentrated caustic soda, bromnitronaphthol is formed.

On **ethenyl diphenyldiamine.**—R. Biederman.—This body has the formula—

$$C_2H_3\begin{matrix}NC_6H_5\\NHC_6H_6.\end{matrix}$$

Neither hydrogen nor bromine could be added to it.

On **ethenyldiphenyldiamine.**—E. Lippmann.—In this case the substance was prepared by treating acetanilid with phosphorus pentachloride.

On **baryta** and **baric superoxide.**—C. Rammelsberg.—When baric nitrate is ignited, the product is an oxide richer in oxygen than baryta. It seems to be $2BaO + BaO_2$.

Analytical Notices.—C. Rammelsberg.—

1. **Estimation of arsenic.**—When ammonio-magnesic arsenate is heated at 100–110°, it loses ammonia, and the results obtained are hence necessarily false. Author recommends that the precipitate, after having been dried at 120°, be ignited with the necessary precautions. The volumetric method of estimating arsenic by saturating the acid liquid with potassic carbonate, adding starch-paste and a test solution of iodine, also, yields good results.

2. **Estimation of iodine in presence of chlorine.**—Cupric sulphate and sulphurous acid give satisfactory results.

3. **Decomposition of certain sulphides** by chlorhydric acid.—Plumbic sulphide and ores or stones that contain this salt cannot be dissolved in nitric acid without the formation of plumbic sulphate. Chlorhydric may be used in such cases.

On the chemical action of the solar spectrum on silver haloid salts.—Hermann Vogel.—The author sums up his results as follows:—

1. Iodide, bromide, and chloride of silver, when exposed for a sufficient length of time, are sensitive for all colors of the visible spectrum to near the line A in red.

2. The maximum of activity lies in general in the violet and indigo, but varies according to the transparency of the atmosphere, particularly in the case of the chloride and bromide.

3. The presence of solution of nitrate of silver influences very materially the sensitiveness to colors of iodide and bromide of silver. It increases the sensitiveness for the more refrangible rays, but decreases the sensitiveness for rays of less refrangibility. In the case of iodide of silver and of iodo-bromide of silver (rich in iodine), the maximum of activity is at the line G when the exposure takes place under solution of nitrate of silver.

4. Other colorless bodies, besides $AgNO_3$, as for instance morphine, cause material variations in the sensitiveness of AgBr and AgI for spectral colors.

5. Absorption-bodies, which increase the sensitiveness of bromide of silver for certain colors, increase in the same manner the sensitiveness of chloride of silver. Plates of chloride of silver can be prepared which, like the human eye, are most sensitive for yellow.

Communications from the Laboratory at Greifswald. —H. Limprich.—

Orthoamidoparasulphotoluic acid was prepared and examined. Its salts and substitution-derivatives are here described.

On the constitution of **bone phosphates.**—C. Aeby. —Author makes the following statements on a basis of experiments :—

Ivory and bones both contain a polybasic phosphate which can be reduced to the same fundamental formula.

The carbonic acid in these complex atomic groups is held with a weak power as compared to that with which it is held in chalk.

The difference in the constitution of orthophosphate and bone phosphate is caused by the differences in the affinity exerted between the ultimate constituents.

On a simple mode of formation of **crotonic acid.**— C. Hell and E. Lauber.—Consists in treating ethylmonobrombutyrate with caustic potash. The acid obtained is identical with the crotonic acid from allyl cyanide.

On **ostruthine,** a new crystallized constituent of plants.—E. v. Gorup-Besanez.—The substance was obtained from masterwort. Its formula is $C_{14}H_{17}O_2$. Alcoholic potassa decomposes it.

Further communication on the **occurrence of leucine** together with **asparagine** during the germinating process of vetches.—E. v. Gorup-Besanez.—The occurrence of leucine under the circumstances indicated in the title is constant.

On the composition of **wool-fat.**—E. Schulze and A. Urich.—Whereas the principal mass of wool-fat consists of compound ethers, a part of the alcohols, and also sometimes a part of the fatty acids, occur in the free state.

On a new formation of **benzcreatine.**—Peter Griess. —A. Volhard prepared creatine by the action of cyanamide on sarcosine. The author has now prepared benzcreatine from cyanamide on amidobenzoic acid.

Preliminary communication on **compounds of iodine and thallium.**—Th. Knösel.—There appear to be at least three compounds of iodine and thallium—a green, a yellow, and a black compound.

Transformation of **β-benzoylbenzoic acid into anthraquinone.**—Arno Behr and W. A. van Dorp.—The change is effected by heating the acid with phosphoric anhydride and sand.

Saccharomyces cerevisiæ and free oxygen.—Adolf Mayer.—Experiments were undertaken to decide whether one and the same yeast-cell can grow, and at the same time cause fermentation. It was proved that only breathing yeast sprouts; and also, that yeast which is no longer breathing oxygen causes fermentation. But it was not proved that fermentation begins exactly at the moment when the free oxygen is used up. On the contrary, there is a broad intermediate stage in which yeast both sprouts and causes fermentation at the same time.

Reduction of trichlorangelactinic acid.—A. Pinner.—When the acid is treated with granulated zinc, a violent action takes place, and the zinc salt of monochlorangelactinic acid is formed. I. R.

Journal für Praktische Chemie.

Nos. 9, 10, 11, 12, 13, and 14, 1874.

On **podocarpic acid.**—A. C. Oudemans, Jr.—This acid is obtained from a resinous exudation of the **podocarpus cupressina,** a native of Java. For minute details of its method of preparation, composition, salts, derivatives, and probable constitution, we refer to this remarkably complete monograph of nearly 70 pages.

Analysis of the **"Deutsch-Kreutzer," Acid Spring.** —R. Fresenius.—Results of analysis :—

Bicarbonate of soda	0·872631
" " lithia	0·000110
" " ammonia	0·003451
Sulphate of potassa	0·047061
" " soda	0·076982
Chloride of sodium	0·096746
Bromide " "	0·000229
Iodide " "	0·000011
Phosphate of soda	0·000561
Bicarbonate of lime	0·963886
" " strontia	0·001450
" " magnesia	0·319398
" " ferrous oxide	0·009539
" " manganous oxide	0·001041
Silicic acid	0·061242
Total	2·454338

Free CO_2 in 1000 c.c. water, 887·19 c.c.

On **sulpho-cyano-carbonic acid** and its derivatives. —L. Henry.— The ether of this acid and some of its salts are described, confirming and supplementing the results obtained by Delitsch.

Researches on the **derivatives of glycerine.**—L. Henry.—Diallyl unites eagerly with hypochlorous acid, forming diallyl-dichlorhydrin $C_6H_{10}(OH_2)Cl_2$; this constitutes a colorless or faintly yellowish transparent very thick viscous liquid possessing a pleasant smell and bitter taste. It is little soluble in water, readily in alcohol and in ether. It cannot be distilled at the ordinary pressure without decomposition. Its constitution is shown thus :—

$$\begin{matrix} C_3H_5\diagup\begin{matrix}OH\\Cl\end{matrix} \\ | \\ C_3H_5\diagup\begin{matrix}OH\\Cl.\end{matrix}\end{matrix}$$

On **unformed ferments** and their reactions.—G. Hüfner.—This article relates to the process of oxidation which takes place when fibrin is gradually decomposed by pancreatic ferments.

On the **sulphur compounds of urethane.**—Sulphocarbonylsulphethylamine $CS\left\{\begin{matrix}SC_2H_5\\NH_2\end{matrix}\right.$ was obtained by saturating sulphocyanide of ethyl with hydrosulphuric acid.

A comparison of the properties of the four urethanes, urethane, carboxylsulphethylamine, xanthogenamid,

and sulphocarboxylsulphethylamine, shows interesting resemblances and discrepancies.

On a new method for preparing **salicylic acid**, and on some of its noteworthy properties.—H. Kolbe.—By heating sodium-phenol in a current of carbonic anhydride, large quantities of salicylic acid are obtained. The reaction is simply thus:—

$$C_6H_5ONa + COO = C_6H_5OCOONa.$$

In this way the author has prepared nearly 50 lbs. with which he is studying its chemical and physiological properties.

On a new method of forming **acrolein from ethylene**.—E. Von Meyer.—The formation of small quantities of acrolein in endiometric experiments is here noticed; it may take place thus:—

$$C_2H_4 + CO = C_3H_4O.$$

On the chemical constitution of **chloride of lime** (bleaching powder).—W. Wolters.—A series of carefully conducted experiments, in which he employed mercury as a means of recognizing and determining chlorine mixed with hypochlorous acid, led the author to conclude that bleaching powder consists of $CaOCl_2$, and possessing the following structure:—

$Ca\begin{matrix}Cl\\ \diagdown\\ =O\\ \diagup\\ Cl\end{matrix}$ if Ca^{IV} may be taken as tetratomic, otherwise thus:—

$$Ca\begin{matrix}OCl\\ \diagdown\\ Cl.\end{matrix}$$

Bleaching powder is readily decomposed by carbonic anhydride, which the author explains thus:—

$$CO_2 + CaOCl_2 = CO_3Ca + Cl_2$$

then follows:—

$$Cl_4 + CO_3Ca = Cl_2Ca + CO_2 + Cl_2O,$$

and the hypochlorous acid sets free chlorine thus:—

$$CaOCl_2 + Cl_2O = Ca(OCl)_2 + Cl_2.$$

In short from $CaOCl_2$ we obtain as final product $Ca(OCl)_2$.

On the dogma of "**catalytic action.**"—G. Hüfner.—First paper. 1. On the historical development of the idea. Historical and metaphysical.

On a new method for the **formation of trimethylphosphine**.—Dr. E. Drechsel.—By heating in sealed tubes at 150° one part of CS_2 with three parts of iodide of phosphonium, the body in question was obtained:—

$$3CS_2 + 4H_4PI = (CH_3)_3HPI + 3H_2S + 3PSI.$$

Rhagit and roselith.—Dr. Clemens Winkler.—Rhagit from Schneeberg gave on analysis:—

Oxide of bismuth	72·76
Arsenic acid	14·20
Ferric oxide } Alumina }	1·62
Cobalt oxide	1·47
Lime	0·50
Water	4·62
Gangue	3·26
	98·43

Hence may be $5Bi_2O_3, 2As_2O_5 + 8H_2O$. Roselith, also, from Schneeberg consists of $3RO, As_2O_5 + H_2O$, in which RO is a mixture of CoO, MgO, and CaO. This mineral is named after the late Gustav Rose. H. C. B.

Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg.

Vol. xviii. No. 5.

On the condensation of the **hydrocarbons of the ethylene series** and the conversion of ethylene into ethylic alcohol.—W. Goriainow and A. Boutlerow.—Ethylene gas is not absorbed at the ordinary temperature by sulphuric acid, but by heating the latter to 160°–175° the absorption takes place rapidly. Upon distilling the acid liquid mixed with water, and treating the distillate with potassic carbonate, considerable quantities of ethylic alcohol are obtained. No product resulting from the condensation of ethylene was noticed, even when fuming sulphuric acid was employed, and the temperature raised to 200°. This stability of ethylene is worthy of notice, and proves that its structure is symmetrical, and not similar to propylene or isobutylene, which condense with great facility.

The authors have made preliminary experiments on the condensation of isobutylene, and surmise the production of isotributylene in addition to the trimethylcarbinol previously observed.

Notice on the **preparation of trimethylcarbinol**, according to the method of Linnemann.—A. Boutlerow. The author considers Mr. Linnemann's directions, as published in the *Annal. der Chem. und Pharm.* 162, p. 15, as not sufficiently exact and complete.

On the formation of **trimethylacetic acid**.—A. Boutlerow.—The author obtained the best results by employing a mixture of isobutylic iodide with a double cyanide of mercury and potassium. The product is submitted to fractional distillation, and certain portions treated with concentrated hydrochloric acid. For details of the process we refer to the original paper, where they are minutely given.

On the **isomeric varieties of amylene**, resulting from the amylic alcohol of fermentation.—F. Flavitzky.—By employing amylic alcohol produced by fermentation, having a constant boiling point at 131°, and having no rotary power optically, the author obtained an amylene similar to ordinary amylene, but boiling ten degrees lower. This he considers an isomer.

Vol. xix. No. 1.

On **supersaturated solutions** and the dissociation of salts in solution, containing water of crystallization.—A. Tscherbatschew.—From certain experiments with supersaturated solutions of sodic sulphate, heated to different temperatures, the author concludes that "water of crystallization, so called, remains combined with salts when they are in a state of solution, and that hydrated salts in solution may experience a dissociation even in the midst of the menstruum." He also considers it probable that the solubility of salts increases with the elevation of temperature, provided their chemical composition (state of hydration) remains unchanged.

H. C. B.

Annales de Chimie et de Physique.

March, 1874.

Researches on the **vapors emitted at the same temperature** by the same body under two different states.—J. Moutier.

Volumetric determination of arsenic and antimony.—A. Houzeau.—This process consists in forming arseniuretted or antimoniuretted hydrogen, passing the gas through a standard solution of argentic nitrate, and then titering back with a standard solution of hydrochloric acid or sodic chloride.

On a peculiar **mineralogical form of silica.**—E. Marchand.—A specimen from Caux, which in appearance resembled a fine-grained limestone, was found to consist of nearly 90 per cent. silica. The name passyite is proposed for it.

Note relative to the **metallurgy of Bismuth.**—A. Valenciennes.—The ore treated at the St. Denis works, from Sucre in Bolivia. It consisted of—

Bismuth	22·80 %	to 30·05 %
Iron	10·20 "	16·90 "
Copper	9·50 "	12·15 "
Sulphur	19.50 "	16·90 "

Also small amounts of antimony, lead, and silver. The ore is first roasted at low red heat, in a reverberatory furnace for twenty-four hours, a little pulverized charcoal being thrown in from time to time. It is then mixed with three per cent. of charcoal and a flux composed of lime, sal-soda, and fluor spar. This is treated in a reverberatory furnace, with a basin in the hearth to receive the metal and slag. A reducing flame is given for about two hours, the mass being frequently worked over; then the doors are opened, and the heat is raised to whiteness until the mixture is perfectly liquid, which takes about two hours. The entire mass is then run off into a cast-iron pot and cooled. Three layers form, the lower consisting of metallic bismuth, the middle of a mixture of bismuth and copper sulphides, while the upper consists of a vitreous scoria containing the iron, etc. The crude bismuth contains two per cent. of antimony, two per cent. of lead, and traces of silver. The mattes containing five to eight per cent. of bismuth are treated as the ore has been, *i. e.*, roasted and again fused with flux. The mattes from this second operation contain one to two per cent. of bismuth, which must be treated in the wet way. The experiment of breaking up the matte, mixing with iron filings and scoriæ, fusing in reverberatory furnace, and then casting, was tried; the result being a mass of bismuth below, and a copper matte above, but the iron sulphide attacked the hearth of the furnace. The process above described was found to be better in this respect, a little silica being added in the second treatment to replace the quartz gangue of the ore. The bismuth is refined from antimony by fusion at red heat with nitre. Copper, lead, and silver are removed by the wet way.

A bismuth ore from St. Angel, France, containing a mixture of wolfram and bismuth oxides, was treated successfully by the wet way as follows: After pulverization it was digested twice with hydrochloric acid. The acid liquors were run off, partly neutralized with soda, and then highly diluted. The precipitate of oxychloride was then separated, washed, and reduced by contact with iron plates, the "cement bismuth" being finally fused with an alkaline flux. The metal thus prepared was found to contain traces of lead and silver. The portion of the mineral insoluble in hydrochloric acid was calcined at red heat with sodic nitrate. The product yielded sodic tungstate on lixiviation with boiling water.

On the discovery of a **source of bismuth in France.**—A. Carnot.—The lithological and mineralogical structure of the region where this occurs is described. The country there consists of a porphyroid granite, with black mica and large feldspar crystals, and containing pockets of radiating crystals of tourmaline, the whole being much eroded. The vein runs through a fine-grained granitoid rock, containing white mica, the rock being in some places greenish and unctuous to the touch. The minerals found in the vein are wolfram, calcic tungstate, hydrated tungstic acid, native bismuth, bismuth sulphide, oxide and hydrocarbonate, large quantities of mispickel, martial pyrites, and hydrated ferric oxide; also, some lead minerals, as the sulphate, carbonate, chlorophosphate, and molybdate. The most of the bismuth ore occurs as oxide or hydrocarbonate. The mode of treatment as given above is described in detail.

April.

Researches on the thermal phenomena accompanying **compression of liquids.**—P. A. Favre and J. Laurent.

Mode of producing **methylamines in manufacturing pyroligneous products.**—C. Vincent.—By distilling crude methylic alcohol in an apparatus furnished with a concentration column, the first portions are found to contain considerable proportions of methylamine and a very little ammonia. This alcohol redistilled several times in the same apparatus contains no more traces of ammonia; but it contains considerable quantities of methylamine, di- and tri-methylamine. The reaction of ammonia on the acetone in the crude alcohol is believed to be the cause of the formation of these methylamines, according to the following formula:—

$$C_6H_6O_2 + NH_3 = C_4H_4O_2 + NH_2(C_2H_3)$$
$$C_6H_6O_2 + NH_2(C_2H_3) = C_4H_4O_2 + NH(C_2H_3)_2$$
$$C_6H_6O_2 + NH(C_2H_3)_2 = C_4H_4O_2 + N(C_2H_3)_3$$

aldehyde being formed.

Distillation of 1 part of ammonia with $2\frac{1}{2}$ parts of acetone gave results appearing to confirm this view.

On the **gases of the blood,** physiological experiments on the circumstances which make the proportion vary in the arterial system.—Dr. Mathieu and V. Urbain.

May.

On the **acid waters** which are formed in the **volcanoes of the Cordilleras.**—M. Boussingault.

On the precautions which should be taken in **taking an assay piece** for the determination of silver in plate.—G. Sire.—The surface of silver plate usually contains a larger proportion of silver as well as other substances as cupric sulphate. In taking a sample the exterior should therefore first be carefully discarded.

Note on the **analysis of superphosphates.**—J. Kolb.—Cold water should be used for the extraction of the soluble phosphoric acid, since hot water decomposes the acid phosphate. Considerable water should be used, and the solution should be rapidly decanted and filtered, otherwise the phosphoric acid, if any is present in the free state, will react on the neutral phosphate and form some soluble phosphate. Joulie's method of titration with the so-called citro-uranic solution; Joulie proposes, in case sulphuric and phosphoric acids are present in the free state, to separate them by treating the sample with alcohol of 80 degrees, but this method is condemned as unreliable.

June.

Study of **phosphorus.**—L. Troost and P. Hautefeuille.—Discussion of the tension of the vapor of phosphorus.

Measure of the **chemical force contained in solar light.**—E. Marchand.—Reply to M. Becquerel.

Experimental researches on **dihydrated sulphuric acid.**—Is. Pierre and E. Puchot.—The latent heat given out by this compound in solidifying appears to be the reason that the crystals are so slow to form in a solution of the acid the temperature of which is maintained at the point where congelation should take place.

Hence it was assumed that the dihydrated acid when mixed with ice should give a lower temperature than the monohydrated acid. Experiments confirmed this view.

Studies on the properties of **explosive bodies.**—F. A. Abel.

Note on the **Egyptian blue.**—H. de Fontenay.—This blue, used as a pigment and frequently mentioned in ancient manuscripts, is found among the monuments of ancient Egypt. On analysis it was found to consist of—

Silica	70·25
Copper oxide	16·44
Iron and alumina	2·36
Lime	8·35
Soda	2·83
	100·23

By fritting together an intimate mixture of

70	parts	white sand
15	"	copper oxide
25	"	chalk
and 6	"	dry soda carbonate,

a similar substance was obtained.

Essay on the reactions of **double decomposition in the dry way.**—G. Gustavson.—The conclusions are as follows: The higher the atomic weight of the element (Bo, Si, Ti, As, Sn) united with chlorine, the more liable the chlorine is to be replaced by the bromine of carbon bromide.

The higher the atomic weight of the element united with bromine, the less liable the bromine is to be replaced by the chlorine of carbon chloride.

Double decompositions in the absence of water depend on the atomic weights of the elements composing the substances which mutually react.

Action of **bromine on bibromsuccinic acid.**—E. Bourgoin.

Researches on **wines.**—E. Duclaux.—In the determination of alcohol in mixtures of water and alcohol, counting the drops falling from a small orifice, combined with observation of the temperature, is recommended; a table is given for an instrument giving 100 drops of distilled water at 15°. The presence of small amounts of ethers was not found by experiment to cause any great error in the determination by this method. The origin of the odorous products in the alcohol of wines is discussed and experiments are detailed.

Pyrogallol in presence of iron salts.—E. Jacquemin.

On the **alloys of hydrogen with the metals.**—L. Troost and P. Hautefeuille.—Sodium and potassium were found to form alloys with hydrogen of the composition Na_2H and K_2H. Lithium and thallium under the same conditions did not form similar compounds. Lithium heated to 500° in hydrogen gas with a pressure of 760 mm absorbed seventeen times its volume. Thallium under those conditions absorbed three times its volume. The compound of hydrogen with palladium is believed from the experiments quoted to be Pd_2H, which however will disolve considerable amounts of hydrogen. The density of hydrogen in combination with metals, as deduced from the specific gravity of the palladium alloy, is 0·62. From that of the sodium alloy the figure 0·63 was obtained. The atomic volume in the sodium alloy was found to be 1·59, in the palladium alloy 1·60, the smallest known atomic volume.

July.

Researches on **wines.**—E. Duclaux.—Determination of the volatile acids of wines. If ten-elevenths of a solution containing a volatile acid is distilled, the distillate contains 80 per cent. of the volatile acid present. This phenomenon occurs with sufficient regularity to render the following process accurate.

Take 275, 550, or 825 c.c. of the wine according to the amount of volatile acids assumed to be present, agitate and if necessary pass a current of air through it to eliminate the carbonic acid, distil off $\frac{1}{10}$, and after passing air through the distillate, titre it with a standardized solution of lime-water, add a slight excess of lime, evaporate to about 250 c.c. to remove the alcohol, add 1 grm. glycerine, and carbonic acid in sufficient quantity to set free all the fat acid. Allow the calcic tartrate to crystallize out, decant, and bring the bulk with wash water up to the bulk of 275 c.c., after having added sufficient tartaric acid to insure that the residue after distillation shall be as acid as the residue from the first operation; 1 grm. of tartaric acid per litre is sufficient. Distil again to $\frac{1}{11}$, and titre the distillate. The relation between the quantity of lime-water used here, and that of the first distillation will serve to establish the quantity of acid existing in the wine. Repeat these operations on the second distillate, adding nothing but the exact amount of tartaric acid necessary. Make the acid liquid up to 150 c.c., and distil off 150 c.c., 50 c.c. will serve to determine the amount of acid, the other 100 are diluted to 100 c.c. and subjected to fractional distillation, 10 c.c. fractions being taken off at a time. The rapidity with which the acids distil over affords data from which may be determined the amount and nature of the acids present. Experiments on solutions containing known amounts of acetic, butyric, metacetic, and valerianic acids, alone and mixed, show with what accuracy this process may be applied. The results of application of this process to the examination of wines which have soured are given.

Study of **three combustibles of the Donetz basin** and a Lignite from Toula, Russia.—A. Scheurer-Kestner and C. M. Dolfas.—

	Grouchesskio anthracite.	Miouckі coal.	Galoubos-ski coal.	Toula lignite.
Hygrometric water	4·08	1·39	4·88	9·39
Ash	1·57	0·23	1·42	16·86
Hydrogen	1·27	4·43	4·75	4·49
Carbon	91·20	89·97	77·47	54·37
Oxygen, nitrogen, sulphur (by difference)	1·88	3·98	11·48	14·78
	100·00	100·00	100·00	100·00
Fixed substances	91·04	80·61	60·88	37·03
Water and volatile substances	8·96	19·39	39·12	62·97
	100·00	100·00	100·00	100·00
Calorific power	8259	8695	8021	7687

Study of the **fumerolles of Nisyros,** and some of the products of eruption of which that island was the scene in 1872 and 1873.—H. Gorceix.

On the influence of the **chemical composition of the soil on the vegetation of the chestnut.**—P. Fliche and L. Grandeau.—The chestnut is found to grow best in silicious soils. Nevertheless it takes up from the soil a considerable proportion of lime. On lime soils it takes up too much lime for its welfare, other elements, as potassa and iron, not being absorbed in such quantities as to contribute to the perfect development of the tree. Hence the chestnut does not grow well in a calcareous soil.

On **soluble starch.**—M. Musculus.—The best mode of preparation of this substance was found to be as follows: Put 400 grms. of starch in a flask containing two litres of a solution of sulphuric acid of $\frac{1}{50}$. Heat until the solution is effected. Then add chalk, to arrest the action of the acid, filter, and evaporate to a syrupy consistency; filter again to separate the calcic sulphate,

and set aside in a cool place. After twenty-four hours have elapsed, the solution begins to cloud, and finally gives a bulky white deposit of soluble starch, which may be separated and washed. If left for some time in contact with water it slowly dissolves, a little sugar being produced. Its rotatory power is nearly four times that of anhydrous glucose. Alcohol precipitates it from its solution in an insoluble state.

Researches on **trichlor acetic acid and the trichlor acetates.**—A. Clermont.—The different modes of preparing this acid are given. The author's method consists in digesting chloral hydrate with three to four times its weight of fuming nitric acid; after the nitrous fumes cease to be evolved, which is in two or three weeks, the mixture is then distilled, the portion coming over at 195° being the pure trichloracetic acid. This acid solidifies at 44·8° and liquefies at 52·4°, with a vapor density of 5·3. Various trichloracetates are described, and the results of analyses of them given.

August.

Researches on **mannite.**—Leo Vignon.—The paper is divided as follows: I. Introduction. II. Rotatory power of mannite. III. Nitro mannitene, $C_{12}H_3(NO_6H)_5$. IV. Action of water on mannite in sealed tubes at different temperatures, mannitane ether $(C_{12}H_{13}O_{11})_2$, mannitone $C_{12}H_{12}O_{10}$.

Studies on **the soil.**—Th. Schloesing.

Researches on the **simultaneous diffusion of some salts.**—C. Marignac. E. W.

La Sucrerie Indigene.

No. 23.

Analysis of beet pulps.—A. Vivien.—In taking the sample, the proportion of the amount of pulp to the amount of pieces of the beet which have escaped the action of the rasp must be carefully taken into account. The analysis is made as follows: For water, organic matter, and ash, 10 grammes are to be taken, dried to a constant weight, and then ignited at low red heat as usual. For sugar, 500 grammes are carefully rubbed up with clean sharp sand (previously washed with acid and ignited), 500 grammes of water at 95° added, mixed, and pressed through a linen cloth. Cool, and test by Vivien's saccharometer, and on this liquid make tests by polariscope and by the cupro-potassic tartrate for glucose; the latter after precipitating the gum, etc., by a small amount of basic lead acetate. The mode of calculating and interpreting the results is given.

Losses of **alcohol in distilleries.**—Description of Savalle's apparatus for determination of alcohol in wine must, etc.

Practical course in **sugar making.** Boiling syrups and crystallization of the sugar.—A. Vivien.

No. 24.

Practical course in **sugar making.**—A. Vivien.—Boiling syrups with sulphurous acid. Seyferth's process. Description of the apparatus, accompanied by a diagram.

Vol. ix. No. 1.

Sebor's process for **extracting sugar from molasses.**—E. Felz.—This method, regarding which important details have been carefully kept secret, is believed by the author to consist essentially in forming an impure sucrate by treatment with lime, and then subjecting the mixture to osmotic action. The advantages of the process, it is stated, are at present uncertain.

Practical course in **sugar making.**—A. Vivien.—Comparison of the old with the new methods of boiling down sugars—Manufacture of bone-black—Hints on the mode of manufacture.

No. 2.

Practical course in **sugar making.**—A. Vivien.—Revivification of the black—Mode of washing—Advantages and disadvantages of different methods. E. W.

BOOKS RECEIVED.

Tables for Qualitative Chemical Analysis, with an Introductory Chapter on the Course of Analysis. By Prof Heinrich Will, of Giessen, Germany Second American, from the ninth German edition. Edited by Charles F. Himes, Ph.D., Professor of Natural Science, Dickinson College, Carlisle, Pa. Philadelphia: Henry Carey Baird, Industrial Publisher, 406 Walnut Street. 1874. 8vo.

A tabular form of presenting the methods employed in qualitative chemical analysis possesses considerable advantages over the more common plan of ordinary text-books. In the former case the eye assists the memory, while in the latter much confusion arises in the mind of a young student forced to grope amidst the intricate passages of a work with sections, chapters, paragraphs, subdivisions, and cross references.

In the neat volume before us we have a compact and yet explicit scheme of the general course of qualitative analysis; the compounds being classified according to the properties relied upon for their detection, we have a thread around which chemical facts may crystallize as they accumulate.

Tables of course cannot give the minute details contained in the manuals on analytical chemistry, and the student is constantly referred to some one of these for further information. Personal instruction may and should largely replace the detailed text-books, and it seems to us that tables of the kind here given afford a clear outline to be filled up by the student's experience and the counsel of his instructor.

This second American edition, prepared from the ninth German edition, contains, besides the marks of careful revision, two new tables by the author, embodying Bunsen's valuable flame reactions. Some new matter has also been added by the editor, among which we note an entirely new table for the treatment of the sulphide of ammonium group. The new nomenclature ("hydric sodic sulphate;" "ferric oxide" for example), together with the new atomic weights in the formulæ, are employed throughout the work

The book presents a neat typographical appearance, but its black cloth cover, innocent of gilt lines, is rather forbidding and old-fashioned in these days of bright hues of the chemist's manufacture and discovery.

An address at the Dedication of Pardee Hall, Lafayette College, October 21, 1873 By Rossiter W. Raymond, Ph.D. Pamphlet, 8vo. 40 pp. Easton, Pa., 1873.

Proceedings of the American Academy of Arts and Sciences, vol. x. Researches on the Hexatomic Compounds of Cobalt. By Wolcott Gibbs, Ph.D. Pamphlet, 8vo. 38 pp. (to be continued).

BREVITIES.

The Quantity of Sugar Consumed in Great Britain in 1700 was only 10,000 tons, while in 1868 it was nearly 700,000. The following table, though not quite perfect, shows correctly enough for general readers the quantity consumed in various years, the number of pounds per head of the population, the price per cwt. including duty, and the amount of duty paid on all descriptions of sugars:—

	Quantity consumed in tons.	Pounds per head.	Average duty per cwt.	Average price including duty.	Total duty paid.
			s. d.	*s. d.*	£.
1700.....	10,000	3	..	..	....
1754.....	53,270	12	..	..	....
1801.....	159,916	22	20 0	79 5	3,066,163
1821.....	170,612	18	27 0	60 2	4,188,997
1841.....	202,899	17	25 2	64 1	5,114,390
1851.....	328,581	26	12 0	37 6	3,979,141
1861	446,865	34	13 10	40 4	6,104,325
1867.....	625,000	47	10 0	40 0	5,816,445

It is estimated that the annual production of sugar over the world amounts to 3,000,000 tons. Roughly dividing the nations into groups, the interesting fact is shown that the Anglo-Saxon races—Great Britain and her colonies and the United States—are the most important consumers, as they use 1,142,000 tons of sugar per year, or 41·4 pounds per head. The Latin races come next—France, Italy, Spain, Belgium, Portugal, and Switzerland use 506,000 tons per annum or 12 34 pounds per head. The Zollverein, Austria, Holland, the Hanseatic League, and Denmark consume 262,000 tons per annum, or 7·3 pounds per head. Last come the vast but poverty stricken districts ruled by Russia, together with the semi-barbarous Ottoman empire, and the kingdom of Greece Russia, Poland, Turkey, and Greece consume less than half of what is used by the smallest civilized European consumers, and the deliveries in these countries amount to only 125,000 tons, or 3·3 pounds per head. The

following statement of the imports into the Clyde during the past twelve years will show the progress of this trade:—

	Sugar, tons.	Molasses, tons.
1857	38,336	9,551
1858	56,769	15,077
1859	69,991	9,720
1860	75,087	4,952
1861	88,694	18,229
1862	106,748	14,802
1863	121,044	5,664
1864	126,061	3,483
1865	136,540	3,708
1866	162,368	2,912
1867	178,013	2,919
1868	171,643	4,880

—*Industries of Scotland.*

Upon Atmospheric Dust.—Tissandier.—The author has determined the amount of solid corpuscles in a known volume of air in Paris, and the chemical composition of the dust. In one cubic metre of air the following weights were found:—

After rain.	After eight dry days.	In normal atmospheric condition.
.006 grm.	.023 grm.	·0060 grm.
		·0075 "
		·0080 "

The organic particles of the dust were found to reach one-tenth mm. in length; the inorganic to be from one-hundredth to one-thousandth mm. in diameter. Upon a glazed paper one square metre in surface, exposed in a calm night ten to fifteen metres from the ground, the author collected, in spite of inevitable losses, from ·0015 to ·0035 grm. of deposited dust. The organic matter of the dust varied from twenty-five to thirty-four per cent. and the inorganic from seventy-five to sixty-six per cent. The author gives the following analysis of dust collected from an undisturbed location in one of the towers of Notre Dame:—

Organic matter	32·26
Matter soluble in water	9·22
" " " hydrochloric acid	24·18
Inorganic matter	34·33
	99·99

The Action of Light upon Silver Bromide, M. Carey Lea concludes, is to form a subbromide or an oxybromide, and not an oxide of silver. With silver iodide the action is analogous.

Jannettaz calls attention to the fact that a fragment of bisulphate of potassa thrown upon coarsely powdered galena gives rise to an immediate development of sulphydric acid gas. With the sulphides of antimony, iron, mercury, and silver, no sensible disengagement of gas is obtained.

Detection of Blood Spots.—M. Sonnenschein employs for the detection of blood spots tungstate of soda, strongly acidulated with acetic or phosphoric acid, which throws down albuminoid matters from very dilute solutions. These precipitates, insoluble in a large excess of water, dissolve in alkalies, especially if hot. If defibrinated blood is treated with this salt, a red-brown precipitate is formed, which becomes clotted on boiling. All the coloring matter is thrown down. To detect blood spots by this means, on clothing, etc., the suspected portion is cut off, and after having been treated with distilled water, the filtered solution is precipitated with the above reagent. The precipitate, washed and treated with ammonia, takes a reddish-green coloration. If phosphoric acid is present it must be carefully washed away before treating the precipitate with ammonia.—*The Engineer.*

The Presence of Tin and Cobalt in the Kaolins of the Department of Allier.—Gouvenain.—In the concentrated washings of the kaolin from the works at Coleties, tin has been obtained free from tungsten, arsenic, and antimony, but leaving behind, in the quartz residue, on treatment with hydrochloric acid, titaniferous iron.

The unwashed, crude sand gave ·05 parts of tin per 100. The micaceous quartz rock, crossing the deposit of kaolin, contained ·02 parts of tin per 100. Not only the kaolin, but all the minerals connected with it are stanniferous.

The kaolin of Colettes contains manganiferous nodules, containing—

Copper	1·4
Cobalt	·04
Phosphoric acid	·80
Nickel	traces.

Upon some Acid Salts.—Lescoeur.—The author has established the existence of the following salts:—

Quadrisulphate of potash.....$KO,4SO_3,6HO$
" " soda.....$NaO,4SO_3,6HO$
Triacetate of potash.....$KO,C_4H_3O_3,2C_4H_4O_4$
" " soda.....$NaO,C_4H_3O_3,2C_4H_4O_4$.
—*Comptes Rendus.*

Dialysis of Silico-aluminate of Soda.—Le Chatelier.—Experiments made in dialyzing a silico-aluminate of soda of the composition—

SiO_2	44·6 per cent.
Al_2O_3	26·4 "
NaO	16·3 "
HO	12·7 "

gave the following results: 20 c. c. of *alkaline* solution, containing—

SiO_2	·2 grammes
Al_2O_3	·3 "
NaO	3·8 "

left on the membrane a white pulverulent powder containing—

SiO_2	·12 gramme
Al_2O_3	·115 "

and no determinable quantity of alkali. All the alkali had passed through the membrane, carrying with it—

Al_2O_3	·105 gramme.
SiO_2	·010 "

The colloidal solution of silico-aluminate has not been realized, but a precipitate formed of almost equal parts of alumina and silica has been separated by dialysis, while the excess of alumina has gone through the membrane with a small quantity of silica.—*Comptes Rendus.*

The Cultivation of Madder in France.—Chemists have a long time foreseen that the successful production of alizarine from anthracene must, before long, close up the cultivation of madder, which has been by no means one of the most trifling sources of wealth for France. The loss of the madder fields, too, will not only affect the material prosperity of France, but will certainly remove from its eastern and southern departments one of their prettiest and gayest products. M. Engell Dollfus, of Dornach (Alsace), has submitted to the Central Society of Agriculture certain statistics which indicate how the foreign demand for French madder is diminishing. According to him, in the first eight months of 1873, 1,696,685 kilogrammes were exported. In the corresponding period of 1872, 2,523,534 kilogrammes were bought by foreign customers. The quantity shipped to England in those periods was, in 1872, 821,974 kilogrammes; in 1873, 693 648 kilogrammes. This seems to show that English dyers have not adopted the artificial dye so readily as other countries. The writer remarks that for reds and rose tints the madder flowers are still preferred to the artificial alizarine; but for violets the latter produces much more economically shades fully as rich as those obtained from the plant.—*The Chemist and Druggist.*

India-rubber.—The increase which has taken place in the consumption of India-rubber during the past forty years may be seen from the following statement of the quantities imported into Britain in various years:—

1830	49,952 lbs.	1852	2,195,984 lbs.
1842	317,184 "	1862	7,405,710 "
1847	659,568 "	1867	8,932,672 "

The chief supplies of India-rubber are derived from Bengal and New Grenada, and the price ranges from £120 to £200 per ton. The value of the raw and manufactured rubber exported annually now amounts to £1,000,000. Our best customers are France and Australia.

The India-rubber arrives at the manufactory in various shapes, according to the mode in which it is collected by the natives of the different countries which produce it. The finest qualities generally come in the shape of curiously formed bottles, and the coarser kinds in roughly kneaded balls about four or five inches in diameter. It is no unusual thing to find stones and other heavy substances mixed with the rubber, for the collectors have learned the art of adulteration. After being softened by steeping in hot water, the rubber passes through the breaking and cleaning machines. The first of these consists of two strongly-mounted iron cylinders, one of which is grooved diagonally, while the other has a smooth surface. The balls of rubber are fed in between the cylinders, which crush them out into thin pieces. These pieces are then operated upon by a machine similar to the first, except that both cylinders are smooth. The rubber is sent through again and again until it is thoroughly broken and assumes the form of a web. On examining the stuff as it comes from the breaking-machine, it is seen, especially in the case of lower qualities, to contain a mixture of bark, leaves, and other foreign matter; and it is to rid it of these that the washing or cleaning machines are employed. Such is the adhesive nature of the material, that it would be impossible to break or clean it in a dry state, and consequently jets of water are made to flow on the rubber and cylinders when the machines referred to are in operation. The water, besides carrying off the impurities set free by the action of the rollers, causes the rubber to assume a granulated appearance, and, under the pressure of the cylinders, it is formed into a web. The webs of washed rubber, which are made only three or four yards long, are taken to a drying-room, where they are hung up in a warm atmosphere for several weeks.

From the drying-room the rubber is taken to the mill, which is of the most powerful construction; for the rubber is stubborn stuff, and submits only to a degree of force that would destroy almost any other non-metallic substance.

The grinding machines, to the operation of which the rubber is next subjected, consist of two cylinders, one of which is slightly heated by steam, and the webs formed by the washing machines are kept revolving round the cylinders until all appearance of granulation disappears, and the stuff becomes quite plastic. At this stage the rubber has incorporated with it sulphur, or other chemical substances, which determine its ultimate character, and is then made up into rolls of seven or eight pounds each. The further treatment of the rubber depends on the purpose to which it is applied. To produce articles of solid rubber the material is rolled out into sheets of various thicknesses, which are by subsequent operations brought into the desired shape.—*The Industries of Scotland;* D. Bremner.

THE AMERICAN CHEMIST.

Vol. V. No. 6.

AN ESSAY ON AMERICAN CONTRIBUTIONS TO CHEMISTRY.*

Read before the Centennial Celebration at Northumberland.

BY PROF. BENJAMIN SILLIMAN,

of New Haven, Conn.

Continued from p. 114.

James Schiel, St. Louis, Mo.—In addition to the titles given on page 111, we note as follows:—

On the Classification of Organic Substances by series, *Am. Journ. Sci.* [2], xxxii. 48, 1861. This author had previously, as early as 1842, enunciated already the principle of progressive series, afterwards adopted by Gerhardt, unchanged, save only in name, under the title of Chemical Homology. Dr. Schiel's original paper was entitled—

"Bemerkungen über die Organischen Radikale," *Liebig & Wöhler's Annalen der Ch., etc.*, xliii. 107. July, 1842.

Dr. Schiel's paper, in 1861, is certainly one of the most important contributions made in America to chemical theory.

Einleitung in das Studium der Organischen Chemie. Erlangen, 1860, 8vo. This excellent treatise followed close upon the author's work on Organic and Gas Analysis, noticed on page 111. It contains a chapter on the classification of organic bodies by series, which fully sets forth the author's original views on this subject.

"On the Presence of Phosphoric Acid in Igneous Rocks." *Am. Journ. Sci.* [2], xxxi. 383, 1861.

The following additional titles of papers by Dr. Schiel are found in *Liebig und Kopp's Annalen, etc.*, Ueber die Angebliche Eigenschaft der Galle, den Zucker in Fett überzuführen, lviii. 96, 1846.

Beiträge zur Kenntniss des Krapps, lx. 74, 1846.

Analyse der Krappsamenasche, lxix. 143.

Alex. Means, LL.D., Prof. Natural Philosophy, Emory College, Oxford, Ga.—Dr. Means has published the following essays and contributions falling within our plan:—

1. A treatise upon "Electro-physiology," published by request of the Class of the Medical College of the State of Georgia, in the year 1840, in which institution the author was for nineteen years Professor of Chemistry and Pharmacy. It was subsequently republished in the *Medical and Surgical Journal*, issued by that college.

2. An article upon "The Dichloride of Mercury (Calomel)," published afterwards in the same Journal, for March, 1845.

3. An essay on "Alcohol—its *History, Pharmaceutical Origin* and *Uses, Chemical Constitution, Medical Claims* and '*Modus operandi*;' together with the *Physiological* and *Pathological Phenomena* consequent upon its administration, and the *Antidotal Treatment* required." Published in the *Augusta Med. and Surg. Journal*, Feb. 1847.

4. An article entitled "The Philosophical Construction of Chemicals," adapted to practical use, and the chemical laws involved explained and illustrated by appropriate diagrams. Published in the *Educational Repository and Family Monthly*, the organ of the "Educational Institute of the Methodist Episcopal Church South," July, 1860.

5. An essay on "Electricity," embracing its history as a science, and its phenomenal manifestation in the organic and inorganic kingdoms of nature. Published serially in *Scott's Monthly Magazine*, Atlanta, Ga., in 1867.

6. An article on "The Poison of Venomous Reptiles." Published in the *Medical and Surgical Journal* of Augusta, Ga., Jan. 1846.

7. Analysis of the Atlanta Mineral Springs, and of the Warm Springs of Merewether County, Ga. Carbonated chalybeate waters; together with the Cold Spring. Acidulo-carbonated chalybeate waters in the same locality. These were published by Mr. George White, formerly of Savannah, in his volume entitled "Statistics of the State of Georgia," in 1849.

Dr. Means has invented several new forms of apparatus for chemical and physical illustration, for which he has received premiums of silver plate. These pieces of apparatus are all to be found in the catalogue of Mr. E. S. Retchie, 1855.

P. D. Keyser, M.D., Philadelphia, Pa.—Dr. Keyser, while a student in Dr. F. A. Genth's laboratory, published the following analyses, which are all to be found in the fifth edition of Dana's Mineralogy.

1853. Owenite from Harper's Ferry. *Am. Journ. Sci.* [2], xvi. 168.

1854. Thalite of Owen. *Ibid.* [2], xvii. 131.

1855. Allanite from Reading and Bethlehem, Pa., and from Orange County, N. Y. *Ibid.* [2], xix. 20.

1857. Barnhardite, a new mineral. *Ibid.*, 17.

Josiah P. Cooke, Jr., of Harvard University, has been an assiduous and successful laborer, both in the field of authorship, teaching, and research, alike in pure chemistry, molecular physics, and theoretical chemistry. His "Chemical Physics," published in 1860, is an elaborate treatise, in advance of anything before attempted in this country, or in fact in our language; and in his "First Principles of Chemical Philosophy" (1868), we have the matured development of an earlier book, "Chemical Problems and Reactions" (1857). These works mark an important advance in the methods of chemical instruction in this country. In the Chemical Philosophy the subject is developed according to the modern theories of the science. In Part First the fundamental principles of the science are discussed, and in the Second Part a brief summary of the more important elements and compounds is given, illustrated and enforced by means of familiar reactions and problems. As is well known, Prof. Cooke had been largely instrumental in changing the older didactic methods of chemical instruction formerly in use, rendering them more

* *Errata.*—On p. 38, 1st column, 10th line from bottom, *for* Prof. A. W. Wright, University of Cincinnati, *read* Yale College, New Haven.
On p. 73, left-hand column, 11th line from bottom, *for* D. Wolcott Gibbs, *read* O. Wolcott Gibbs.
On p. 77, right-hand column, 29th line from top, *for* Vaqnelin, *read* Vauquelin.
On p. 80, left-hand column, 27th line from bottom, *for* Sybert, *read* Seybert.
On p. 85, right-hand column, 6th line from bottom, *for* Brougniart, *read* Brogniart.
On p. 86, left-hand column, 2d line from top, for Brougniart, *read* Brogniart.
On p. 104, right-hand column, 5th line from bottom, *for* Gysolite, *read* Gyrolite.
On p. 105, left-hand column, 20th line from bottom, for New Precipitation, *read* Non-precipitation.
On p. 110, 2d column, 17th line from top, and in each of the five lines following, the references li., lii, lviii., lix. should be xli, xlii., xlviii, xlix. There is no volume beyond l. The third series commences again vol. i., etc.

exact and searching by a free use of the blackboard in the recitation room and laboratory.

In 1854, Prof. Cooke communicated to the American Academy, at Boston, a memoir on "The numerical relation between the atomic weights, with some thoughts on the classification of the chemical elements." This paper is also found in the *American Jour. of Science* ([2], xvii. pp. 387–407), accompanied by a table of the "Isomorphs," "Homologues," and "Atomic weights" of the several series, or groups of elements, with their "affiliations." This memoir received the highest encomiums of Sir John Herschel in his remarks on chemical science, at the Leeds meeting of the British Association for Advancement of Science, in 1858. Its principles are embodied in the author's Chemical Philosophy.

In 1855, Prof. Cooke published a memoir "On an apparent Perturbation of the Law of Definite Proportions observed in the compounds of Zinc and Antimony" and this paper was in September, 1860, followed by a second on the same subject entitled "Crystalline Form not necessarily an indication of Definite Chemical Composition; or on the possible variation of constitution in a mineral species independent of the phenomena of isomorphism." These papers are both founded on the careful study of the compounds of zinc and antimony, the nature of which was first set forth by the same author in his memoir "On Stibiotrizincite and Stibiobizincite, two new compounds of Zinc and Antimony, with some remarks on the decomposition of water by the alloys of these metals" (*American Journ. of Science*, [2] xvii., pp. 229–237); this whole research is a fine model of a chemical investigation. It is noteworthy that two of the gentlemen who were at the time of these investigations students in Prof. Cooke's laboratory, and whose work in this investigation the author gratefully recognizes, are Messrs. Eliot and Storer, names since, and now, so honorably associated in higher, and the highest duties, in Harvard University, and in joint authorship of books on our science of wide use in our best colleges and schools.

Another paper on theoretical chemistry by Prof. Cooke is that "On Atomic Ratio in Mineral Formulæ," published in 1869 (*Am. Journ. of Sci.*, [2] xlvii. pp. 386–390.)

"Chemistry and Religion" is the title of a series of Sunday evening lectures, delivered upon the Graham foundation in Brooklyn in 1861. It is an American Bridgewater Treatise, and considers in an able and attractive manner the proofs of God's plan in the atmosphere and its elements (8vo. pp. 348, N. Y., Chas. Scribner, 1864).

Prof. Cooke's paper "On Danalite, a new mineral species from the Granite of Rockport, Mass." (*Am. Jour. Sci.* [2], xlii. 73, 1866), is a fine example of chemical research, and of the value of accurate observation for the discovery of new and interesting facts in old fields supposed to have been long since gleaned.

Prof. Cooke has lately published "The New Chemistry," a volume of 326 pages in *The International Scientific Series*, which is a lucid and logical discussion of the principles of chemical philosophy in a series of thirteen lectures, which were delivered before the Lowell Institute in Boston, in the autumn of 1872. Of this volume it is remarked by the *Am. Journ. of Sci.* (April, 1874), "Prof. Cooke's style is always attractive for its clearness, precision, and polish, and any cultivated person, whether previously acquainted with chemistry or not, can read this discussion of chemical philosophy with both pleasure and profit. It is needless to add that the subject is discussed, as its title demands, in the terms of the new chemistry."

Of special researches in mineralogical and general chemistry, Prof. Cooke has published many valuable papers, chiefly in the *American Journal of Science*, and in the *Proceedings of the American Academy*, at Boston, special mention of which it is needless to make at this time. His last memoir, "On the Vermiculites," is certainly one of the most important contributions to mineralogical chemistry which has been made by any chemist, at home or abroad, in some years, whether we regard it from its chemical, physical, or mineralogical aspects. It forms part of the ninth volume of the *Proceedings of the American Academy of Arts*, etc., at Boston, and a full abstract of it will be found in the seventh volume of the 3d series of *Am. Journ. of Sci.*, pp. 420–437.

Prof. Cooke has also made many and important contributions to the apparatus for chemical and physical demonstration and research, with the cunning hand of a skilful experimentalist and manipulator.

Under the voluntary or elective system now in vogue at Harvard, and of which Prof. Cooke has been an earnest and successful advocate, that University has now the largest number of under-graduates devoted to chemical studies in their well-appointed chemical laboratories which have been assembled at any academical institution in this country.

John Addison Porter.—The late Prof. Porter, who died in 1866, was a graduate of Yale College in 1842, studied chemistry with Liebig at Giessen after a brief term of service as Professor of Rhetoric and Reub Languages in Newark College, Delaware; was appointed to the chair of Technical Chemistry at Breren University, when in 1853 he was transferred to the chair of Agricultural Chemistry, and then of Organic Chemistry, in the Scientific School at Yale College, afterwards to the Sheffield Scientific School. Prof. Porter was distinguished for his scholarly accomplishments. His published papers in Chemistry are—

1849. "Unterschung der Asche Menschlicher Excremente." *Ann. d. Ch. u. Pharm.*, lxxi. 109.

1849. "Ueber ein Product der Einwirkung der Salpeter säure auf Holzfaser." *Ibid.*, 115.

1850. "Aschenanalyse vol Hafer, Herr und dern Rückstand von der Destillation des Kartoffelbranntweins." *Ibid.*, lxxvi. 382.

1849. "Ash analysis: Potato refuse; Oats; Hay." *Amer. Journ. Sci.* [2], ix. 20.

1849. "A Product of the Action of Nitric Acid on Woody Fibre." *Ibid.*, 20.

Prof. Porter was the author of a Chemical Textbook for Schools, which has passed through many editions. A notice of his life will be found in the *Amer. Journ. Sci.* [2], xlii. 290, 1866.

Newton Spalding Mauross, Ph.D.—The late Prof. Mauross, who fell while gallantly leading a charge at the head of his company in the sixteenth Connecticut Volunteers at the battle of Antietam, September 17, 1862, was then acting Professor of Chemistry at Amherst, Mass. Dr. Mauross was a graduate at Yale College in 1849, and took the Degree of Doctor of Philosophy, at Göttingen, in 1852. Dr. Mauross published:—

1852. "Artificial Formation of Minerals," an inaugural dissertation at Göttingen. The mineral species found and described, with analyses, were Heavy Spar;

Celestine; Archydrite; Apatite; Pyromerphite; Wolfram; Tungsten; Scheeletine; Wolfenite; Crocoirite; and Anglesite. *Amer. Journ. Sci.* [2], xvi. 186, and *Ann. d. Chem. u. Pharm.*, lxxxii. 348.

"Ueber die Künstlicher Darsteltung von Krystaltisirtem Wolframsaurem Kalk." *Ann. d. Chem. u. Pharm.*, lxxxi. 243.

1855. Dr. Mauross also published an interesting "Notice of the Pitch Lake, Lake of Trinidad." *Amer. Journ. Sci.* [2], xx. 153.

Dr. Mauross was chiefly chosen to the work of an explorer and engineer of mines. He made extensive journeys in Mexico, Central America, and Venezuela, and was the first to bring to our notice the Auriferous deposits of the Orouoco.

John Dean, Ph.D., of Boston, Mass.—1. Value of Different Kinds of Prepared Vegetable Food. Communicated to the *Am. Acad. of Arts and Sci.*, April 25, 1844.

2. The Organic Compounds of Tellurium and Selenium belonging to the Alcohol Series. Göttingen, 1855.

Henry Draper, of the University of New York, has made the following contributions upon subjects allied to chemistry:—

1. "On the Functions of the Spleen," in 1857.

2. "On the Use of Protochloride of Palladium," read before the British Association in 1857.

3. "On the use of a Silvered Glass Mirror 15½ inches in Aperture in Photographing Celestial Bodies," published in the *Smithsonian Contributions*, 1860.

4. A paper on "Astronomical Photography," in the *London, Edin., and Dub. Phil. Mag.*, 1864.

5. Memoirs on "The Determination of the Wavelengths of the Ultra-violet Spectrum Lines and Diffraction Spectrum Photography," published in the *American Journal of Science*, 1873; the *Philosophical Magazine*, 1873; *Memoire Degli Spettroscopisti Italiani*, 1873; "*Nature*," 1873; *Poggendorf's Annalen*, 1874; and read before the French Academy, and published in the *Comptes Rendus* in full in 1874.

He also revised and republished in 1866 "Draper's Text-Book of Chemistry."

Matthew Carey Lea, Philadelphia, Pennsylvania.—Mr. Lea has been an industrious worker in chemical research as well as in photographic chemistry. His chemical papers are as follows:—

1858. On Picric Acid and its Salts. *Sill. Journ.* [2], xxvi. 379.

1860. Numerical Relations of the Equivalent Numbers of Elementary Bodies. *Ibid.*, xxix. 98, 349; xxx. 399; [3], iv. 387.

1860. Production of Ethylamine. *Ibid.* [2], xxxi. 401.

1860. Optical Properties of Picrate of Manganese. *Ibid.* [2], xxx. 3, 99.

1861. On a Series of New Combinations of Ammonia, Picric Acid, and Metallic Bases. *Ibid.* [2], xxxi. 78.

1861. Sources of Error in the Employment of Picric Acid to Detect the Presence of Potash. *Ibid.* [2], xxxi. 75.

1861. Effects of Reducing Agents upon Nitrate of Ethyl. *Chem. News*, iv. 230.

1861. Estimation of Nitrogen, and on an Acidimetric Process. *Sill. Journ.* [2], xxxi. 189; *Chem. News*, iv. 195.

1861. Exact Separation of the Ethyl Bases. *Sill. Journ.* [2], xxxii. 26; *Chem. News*, iv. 71.

1861. Formation of Picramic Acid. *Sill. Journ.* [2], xxxii. 188; *Chem. News*, iv. 193.

1861. Preparation of Nitrate and Nitrite of Ethyl. *Sill. Journ.* [2], xxxii. 77, xxxiii. 86; *Chem. News*, iv. 219.

1861. Preparation of Urea from Ferrocyanide of Potassium. *Sill. Journ.* [2], xxxii. 179.

1861. Production of Ethyl Bases. *Sill. Journ.* [2], xxxii. 25; *Chem. News*, iv. 88.

1862. Action of Nitric Acid on Picramic Acid. *Sill. Journ.* [2], xxxii. 210; *Chem. News*, v. 18.

1862. Contributions to History of Picric Acid. *Sill. Journ.* [2], xxxii. 180; *Chem. News*, v. 5.

1862. Further Remarks on the Preparation of the Ethyl Bases by means of Nitrate of Ethyl, and their Separation. *Chem. News*, v. 211.

1862. Estimation of Nitrogen. *Ibid.*, v. 28.

1862. Nitrate of Ethyl. *Ibid.*, v. 158.

1862, 1865. Production of New Coloring Matters by Decomposition of Nitronaphthaline and Dinitronaphthaline. *Sill. Journ.* [2], xxxii. 211, xxxiii. 229, xxxviii. 360; *Chem. News*, v. 73, xi. 230.

1862. Production of Nitrate of Methyl. *Sill. Journ.* [2], xxxiii. 227; *Chem. News*, v. 310.

1862. Reaction of Ethyl Bases with Dr. Knop's New Hydrofluosilicic Acid. *Chem. News*, v. 143.

1862. Reaction of Ethylamine and Diethylamine. *Sill. Journ.* [2], xxxiii. 80; *Chem. News*, v. 127.

1862. On Methylamine. *Sill. Journ.* [2], xxxiii. 366; *Chem. News*, vi. 46.

1862. On Triethylamine. *Sill. Journ.* [2], xxxiv. 66; *Chem. News*, vi. 97.

1863. Arithmetical Relations between Chemical Equivalents. *Chem. News*, vii. 63.

1863. On a Constant Aspirator and Blower. *Sill. Journ.* [2], xxxiv. 245; *Chem. News*, vii. 37.

1864. Notes on Platinum Metals and their separation from each other. *Sill. Journ.*, xxxviii. 81; *Chem. News*, ix. 279, 301.

1864. Remarks on the Distillation of Substances of different Volatilities. *Sill. Journ.* [2], xxxvii. 377; *Chem. News.*

1865. Influence of Ozone and some other Chemical Agents on Germination and Vegetation. *Sill. Journ.* [2], xxxvii. 373; *Chem. News*, xi. 229.

1865. On the Platinum Metals. *Sill. Journ.* [2] xxxviii. 248; *Chem. News*, xi. 3, 13.

1865. On the Nature of the Invisible Photographic Image. *Sill. Journ.*, xl. 109; *Chem. News*, xii. 101.

1865. Reaction of Gelatine. *Sill. Journ.* [2], xl. 81; *Chem. News*, xii. 73.

1866. Detection of Iodine. *Sill. Journ.* [2], xlii. 109; *Chem. News*, xiv.

1867. A New Test for Hyposulphites. *Sill. Journ.* [2], lxiv. 222; *Chem. News*, xvi.

1868. On Nitroglucose. *Sill. Journ.* [2], lxv. 381; *Chem. News*, xviii.

1864. Coloration of Faded Photographs. *Sill. Journ.* [2], xxxvii. 438.

1865. Ozone on Insensitive Iodide and Bromide of Silver. *Ibid.* [2], xxxix. 210.

1867. A Theory of Photo-Chemistry. *Ibid.* [2], xliv. 71.

1867. Germination. *Ibid.* [2], xliii. 197.

1867. Light on Iodide of Silver. *Ibid.* [2], xlii. 198.

1869. Transmitted and Diffused Light. *Ibid.* [2], xlii. 364.

1872. Method of Estimating Ethylic Alcohol when present in Mythylic Alcohol. *Ibid.* [3], iii. 365.

1874. A Combination of Silver Chloride with Mercuric Iodide. *Ibid.* [3], vii. 34.

1874. Color and Reduction by Light. *Ibid.* [3], vii. 200.

1874. Laboratory Notes. *Ibid.* [3], vii. 376.

1874. Action of Light on Silver Bromides. *Ibid.* [3], vii. 483.

In addition to the foregoing Mr. Lea has published over one hundred papers on photo-chemical and photographic subjects which have appeared in the British Journal of Photography and other photographic journals. He is also the author of a Manual of Photography, the first edition of which appeared in 1868 and the second in 1871.

Chas. F. Chandler, Ph.D., New York, Professor of Chemistry in the Columbia College School of Mines, etc., has been an industrious working chemist, and charged with numerous responsible duties of administration in the School of Mines and in other educational and public institutions in New York.

He has made the following contributions:—

1. Miscellaneous Chemical Researches.

Inaugural Dissertation for the Degree of Doctor of Philosophy. Göttingen, 1856.

I. Zircon from Buncombe County (North Carolina).
II. Saussurite from Zobten.
III. Stassfurthite from Stassfurth.
IV. Analysis of a rock resembling Talcose Slate, from Zipser.
V. Columbite from Middletown.
VI. Columbite from Bodenmais.
VII. Tantalite from Chanteloube.
VIII. Yttrotantalite from Ytterby.
IX. Samarskite from the Ural.
X. Experiments on the Cerium Metals.
XI. Artificial Heavy Spar.

2. An Investigation on the formation of Alcohol during fermentation. Published in "Biblical Temperance," by E. C. Delavan, Esq.

3. Analysis of Dolomite. In the Report of the Geological Survey of Iowa, by James Hall and J. D. Whitney. Albany, 1858.

4. Examination of Interesting Urinary Calculi, included in a report of Dr. Alden March. Printed in the Annual Report of the N. Y. State Medical Society for 1858.

5. Analysis of Datolith. *Am. Journ. Sci.*, 1859, xxviii. p. 13.

6. A new Metal in the Native Platinum of Rogue River, Oregon. *Ibid.*, May, 1862, p. 351.

7. Analysis of 1 Blende, 2 Smithsonites, 1 Cerusite; and with J. P. Kimball, analyses of 9 Shales, 5 Galenas, 1 Dolomite.

In the Report of the Geological Survey of the Upper Mississippi Lead Region, by Prof. J. D. Whitney. Albany, 1862.

8. Report on Water for Locomotives and Boiler Incrustations, made to the President and Directors of the N. Y. Central R. R., including analyses of Waters between Albany and Niagara Falls, and Analyses of Incrustations. Pamphlet, 8vo. 35 pp. New York, 1865.

9. Report on the Petroleum of the Taro, Italy. 8vo. 8pp. New York, 1866.

10. Sanitary Qualities of the Water Supplies of New York and Brooklyn. Report to the Metropolitan Board of Health. 8vo. 9 pp. New York, 1868.

11. Analysis of the Ballston Artesian Spring. By C. F. Chandler and E. Root. *American Supplement to the Chemical News*, July, 1869, p. 54.

12. A New System of Assay Weights. *Ibid.*, August, 1869, p. 113.

13. Analyses of six New Mineral Springs at Saratoga. *Ibid.*, Sept. 1869, p. 194.

14. Analysis of the Saratoga Seltzer Spring. By C. F. Chandler and Paul Schweitzer. *Ibid.*, Dec. 1869, p. 395.

15. Report on the Quality of the Milk Supply of the Metropolitan District; made to the Metropolitan Board of Health. 8vo. 13 pp. New York, 1870. Also in the *Am. Chemist*, August, 1870, p. 41.

16. Report on the Water Supply of New York and Brooklyn; made to the Metropolitan Board of Health. 8vo. 9 pp. New York, 1870.

17. Report on the Quality of the Kerosene Oil sold in the Metropolitan District; made to the Metropolitan Board of Health. 8vo. 23 pp. New York, 1870.

18. Report on the Gas Nuisance in New York; made to the Metropolitan Board of Health. Including a special discussion of the different methods of purification. 8vo. 109 pp. New York, 1870.

19. Report on Dangerous Cosmetics; made to the Metropolitan Board of Health. 8vo. 7 pp. New York, 1870. Also in *American Supplement to the Chemical News*, May, 1870, p. 293.

20. The Purification of Coal Gas, and the Gas Nuisance in New York. *Ibid.*, February, 1870, p. 117; March, 1870, p. 177.

21. Analyses of the Chittenango Sulphur Springs, Madison Co., N. Y. *Ibid.*, April, 1870, p. 221.

22. Saltness of the Waters around the Island of New York. *Ibid.*, April. 1870, p. 225.

23. A Simple Lecture Experiment to show the Solubility of Carbonate of Lime in Carbonic Acid. *Ibid.*, April, 1870, p. 228.

24. Analysis of the Geyser Spring of Saratoga. By C. F. Chandler and F. A. Cairns. *Ibid.*, June, 1870, p. 373.

25. Lecture on Water; delivered before the American Institute. 8vo. 49 pp. Albany, 1871.

26. Lecture on Water. (Revised and Elaborated.) *Am. Chemist.*

1. General. November, 1871, p. 161.
2. Mineral Waters. December, 1871, 201.
3. Water for Manufacturing and Domestic Purposes. January, 1872, p. 259. February, 1872, p. 281.
4. The Croton. March, 1872, p. 321.

27. Report on Petroleum as an Illuminator, and the Advantages and Perils which attend its Use, with Special Reference to the Prevention of the Traffic in Dangerous Kerosene and Naphtha; made to the Health Department of the City of New York. 8vo. 110 pp. New York, 1871.

28. Analysis of the Florida Sulphur Spring. *Am. Chem.*, February, 1871, p. 300.

29. Reduction of Nitrate of Silver by Charcoal. *Ibid.*, March, 1871, p. 346.

30. Analyses of Staten Island Waters. By C. F. Chandler and F. A. Cairns. *Ibid.*, March, 1871, p. 347.

31. Composition of Commercial Zinc. *Ibid.*, May, 1871, p. 420.

32. Condensed Milk; its Manufacture and Composition. *Ibid.*, July, 1871, p. 25.

33. Report on the Water of the Hudson River;

made to the Water Commissioners of the City of Albany. A special discussion of the destruction of the sewage contamination of large rivers, caused by the dissolved oxygen. 8vo. 25 pp. Albany, 1872.

34. Report on Petroleum Oil, its Advantages and Disadvantages; made to the Department of Health, (Revised and Elaborated.) *Am. Chem.*, May, 1872, p. 409; June, 1872, p. 446; July, 1872, p. 20; August, 1872. p. 41.

35. Analysis of the Empire Spring at Saratoga. By C. F. Chandler and F. A. Cairns. *Ibid.*, Sept., 1872, p. 93.

36. Analysis of the Glacier Spouting Spring at Saratoga. By C. F. Chandler and F. A. Cairns. *Ibid.*, November, 1872, p. 165.

H. B. Nason, Ph.D., Professor of Chemistry, Rensselaer Institute, Troy, N. Y.—Prof. Nason has published in the German journals some time since papers of which he has supplied only the titles, as follows :—

On the Formation of Ether.

On the Analysis of Meteoric Masses.

On some Minerals of Iceland named by Waltershausen.

On the Mineral called Skeroklas by Sartorius v. Waltershausen.

And subsequently :—

Table for Qualitative Analysis, indicating color of precipitates with diagrams.

Translation, with many additions, of Wöhler's Mineral Analysis.

1873. Elderhorst's Manual of Blowpipe Analysis. Edited with C. F. Chandler.

Frank H. Storer, Bussey Agricultural College, Harvard University, Jamaica Plain, Mass.—Prof. Storer's "Dictionary of Chemical Solubilities," and his "Cyclopedia of Quantitative Analysis," are the constant companions of every American chemist. He has also published the following papers :—

1858. "Behavior of $\bar{C}aC$ and $\bar{B}aC$ with various Saline Solutions; on the Determination of Carbonic Acid." *Sill. Journ.* [2], xxv. 41.

1858. On Larves of Flies resisting Arsenic. *Ibid.* [2], xxviii. 166.

1860. On Loss of Light by Glass Shades. *Ibid.* [2], xxx. 420, xxxi. 284.

1860. Review of Antisell on Photogenic Oils. *Ibid.*, xxx. 112, 254.

1861. On Impurities of Zinc. *Ibid.* [2], xxxi. 142, xxxii. 380.

1861. Alloys of Copper and Zinc. *Ibid.* [2], xxx. 286. 423.

1861. Lead in Silver Coins. *Ibid.* [2], xxxi. 430.

1861. Keroselene. *Ibid.* [2], xxxii. 276.

1862. American Process of Working Platinum. *Ibid.* [2], xxxiii. 124.

1862. Arsenic Eating in Styria. *Ibid.* [2], xxxiii. 126.

1867. Hydrocarbons from Animal Fats. *Ibid.* [2], xxxiii. 250.

1867. Naphtha from Rangoon Petroleum. *Ibid.* [2], xliii. 251.

1869. On Nitric Acid and Chlorate of Potassium as an Oxidizing Mixture. *Ibid.*, xlviii. 190.

1859. Dépôt de soufre dans les tuyaux à gaz. *Rept. de Ch. App.*. 495.

1860. Influence de l'argent sur la durée des doublages. *Ibid.*, 82.

1861. Sur l'extrême difficulté qu'on éprouve à enlever les dernieres traces d'acide carbonique d'une volume considerable d' air atmospherique. *Rept. de Ch. App.*, 205.

1861. La question du pain aéré, description du procédé Horsford. *Ibid.*, 347.

1861. Sur le chromate de chrome et les chromates analogues. *Ibid.*, 390.

1861. Recherche du chrome en présence du fer. *Ibid.*, 58.

1863. Substitution du verre soluble au savon resineux dans la fabrication des savons. *Ibid.*, 5.

1863. Sur les cartouches imperméables de M. Dornbach. *Ibid.*, 91.

1863. Sur la contrafaçon des billets de banque. *Ibid.*, 109.

1865. Hydrocarbon Naphtha obtained from Product of Destructive Distillation of Lime Soap. Jointly with C. M. Warren. *Am. Acad. Bost.*, vii. 1.

1863–64. First Outlines of a Dictionary of Solubilities of Chemical Substances. 1 vol., 8vo., pp. 713.

1863–64. Memoir on the Alloys of Copper and Zinc, 4to.. pp. 29.

1866. Ethics of Adulteration. *Harper's Magazine*, xxxii. 635.

1870. Soluble lead-salt and free $\bar{S}$ in sherry wine. *Chemical News*, xxi. 17.

1870. Assay of Galena. *Ibid.*, xxi. 137.

1870. Examples for Practice in Quantitative Analysis. *Ibid.*, xxii. 89, 187.

1870–73. Cyclopædia of Quantitative Analysis. 8vo., 2 parts, pp. 112 and 113–224.

1874. Bulletin of the Bussey Institution [Jamaica Plain (Boston)]. 8vo., 2 parts, pp. 80 and 81–184. Cambridge.

With Charles W. Eliot.

1874. A Manual of Inorganic Chemistry, arranged to facilitate the Experimental Demonstration of the Facts and Principles of the Science. 1 vol., 8vo.

1874. A Compendious Manual of Qualitative Chemical Analysis. 1 vol., 8vo.

1874. Memoir on the Impurities of Commercial Zinc. 4to., pp. 39.

James P. Kimball, PhD., F.G.S., Professor of Geology in Lehigh University.

On Sodalite and Elaeolite from Salem, Mass. *Am. Jour. of Arts and Sciences*, 1859.

A series of analyses of bituminous shales in connection with Prof. C. F. Chandler. Geology of Wisconsin, Vol. I., by Prof. J. D. Whitney.

On Aluminous Magnetite (Emery) and its uses in Iron Metallurgy. *Am. Chemist*, Vol. IV., p. 321.

Dr. Kimball's contributions to science have been mainly geological.

C. Gilbert Wheeler, Prof. of Chemistry in the University of Chicago, Illinois, has made the following contributions to our chemical literature :—

1859. Analysis of various Missouri Coals. *Report of Missouri Geological Survey.*

1865. The Inorganic Constituents of Bavarian Hops and Analyses of the Leading Soils on which they are cultivated. *Journal für Praktische Chemie*, vol. xciv.

1865. A Method of Determining Carbon, Hydrogen, Nitrogen, and Oxygen at one Operation. *Ibid.*, vol. xcv.

1867. On the Action of Zinc and Sulphuric Acid upon Cyanacetic Acid. *Ann. Chem. and Phar.*, vol. cxliii. *Bull. Soc. Chem.* [2], viii. 116.

1867. On the Bisulphide of Phenyl, and the Bisulphide of Brom-phenyl. *Zeitsch. für Chem.*, 1867, pp. 436.

1867. Action of Hypochlorous Acid on Oil of Turpentine. *Bull. Soc. Chim.* [2], x. 288.

1867. Action of Hypochlorous Acid on Camphor. *Zeitsch. Chem.*, 1868, 122.

1866. On a Method of Determining C.H.N+O at one operation. *Am. Jour. Sci. and Arts*, 1866, January number.

1868. Action of Binoxide of Manganese on Uric Acid. *Am. Jour. Sci. and Arts* [2], vol. xliv. p. 218.

1871. Recent Progress in Chemistry in the United States. Read before the British Association at Edinburgh, 1873.

1872. On the Polyscope, a new Optical Instrument. Read before the American Association at Dubuque.

1873. Analysis of Spring Lake and Frankfort Mineral Waters. Published in Dr. Watson's "Mineral Springs of the United States."

1874. Analysis of the Mineral Water of Grand Haven. Completed and about to be published in *Am. Jour. of Sci. and Arts.*

Note.—Many of the above were copied into other journals of England, France, and Germany.

C. M. Warren, Brookline, Massachusetts.—Prof. Warren, formerly of the Massachusetts Institute of Technology, whose researches upon the volatile hydrocarbons are so well known, has made the following contributions to chemistry.

1860. On some Compounds of Zirconia and Titanic Acid.

1. A New Sulphate of Zirconia, containing some Potassa.

2. A Double Sulphate of Zirconia and Potassa.

3. A Double Sulphate of Titanic Acid and Potassa. *Pogg. Ann.*, cii. 449.

1862. On a Safety Heating Lamp for use in Laboratories. *Am. Journ. Sci. and Arts*, [2], xxxiii. 275.

On a Process of Organic Elementary Analysis, by Combustion in a Stream of Oxygen Gas. *Proc. Am. Acad.*, vi. 251.

On a Process of Fractional Condensation Applicable to the Separation of Bodies, having small differences between their boiling-points. *Mem. Am. Acad.*, N. S., ix. 121.

Researches on the Volatile Hydrocarbons:—

1. On the Volatile Hydrocarbons from Coal-tar Naphtha.

2. On the Volatile Hydrocarbons from Oil of Cumin and Cuminic Acid. *Mem. Am. Acad.*, N. S., ix. 135.

On the Influence of CH_2 upon the Boiling-points in Homologous Series of Hydrocarbons, and in some Series of their Derivatives; with critical observations on methods of taking boiling-points. *Loc. cit.*, p. 156.

On a New Process for the Determination of Sulphur in Organic Compounds, by Combustion with Oxygen gas and Peroxide of Lead. *Proc. Am. Acad.*, vi. 472.

On a New Process of Organic Elementary Analysis for substances containing chlorine. *Proc. Am. Acad.*, vii. 84.

Note on an Improved Apparatus for the Determination of Vapor Densities, by Gay-Lussac's Method; being a modification of Bunsen's apparatus for measuring aqueous vapor. *Proc. Am. Acad.*, vii. 99.

In joint authorship with F. H. Storer.

Researches on the Volatile Hydrocarbons:—

Examination of a Hydrocarbon Naphtha, obtained from the Products of the Destructive Distillation of Lime Soap. *Mem. Am. Acad.*, N. S., ix. 177.

Examination of Naphtha, obtained from Rangoon Petroleum. *Loc. cit.*, p. 208.

Frederick Hoffmann, Ph.D., New York.—Dr. Hoffmann's chemical papers and publications are as follows:—

Untersuchungen der Bleiweiss Sorten des Handels. *Hirzel's Zeitschrift für Pharmacie*, 1852–1853.

Untersuchungen der Weinstein Sorten des Handels. *Hirzel's Zeitschrift für Pharmacie*, 1852–3.

Ueber die Ermittlung des Phosphor in der gerichtlich-chemischen Analyse. *Berliner Allgemeine Medicinischs Central Zeitung*, 1859, *Kopp & Will Jahresberichte*, 1859, p. 663.

A Critical Review of the History of Anilin and the Anilin Colors. Sacket & Cobb, New York, 1863.

Die Steinkohlen und deren Destillations Producte. A course of lectures delivered before the New York Gewerbe Verein. *Sonntagsblatt N. Y. Statts Zeitung*, 1863.

Die Chemie und das Leben. A popular lecture. *Butz, Deutsch-Amerikanische Monatshefte*, Chicago, 1864.

Arabesken, am der Geschichte der Chemie. *Butz, Deutsch-Amerikanische Monatshefte*, Chicago, 1864.

Annual Report on the Progress of Pharmacy and Pharmaceutical Chemistry. Philadelphia, 1868.

On the Preparation of Zinc Sulpho-phenate. *Amer. Journ. of Pharmacy*, 1870.

Manual of Chemical Analysis, as applied to the Examination of Medicinal Chemicals. New York, 1873.

Dr. Hoffmann's "Manual," last named, is a work of very high character, and has received well-deserved commendation wherever it is known.

Maurice Perkins, Prof. of Chemistry Union College, Schenectady, N. Y.—Prof. Perkins has published An Analysis of the Parotid Saliva, in Dalton's Physiology.

P. B. Wilson, Baltimore, Md.—Mr. Wilson has contributed the following papers:—

1859. 1. On Wax obtained from Myrica cerifera (in Genth's Laboratory).

2. Electro-metallurgical Preparation of Chemically pure Metals, prepared for Bunsen and Kirchhoff, for their Spectroscopic Investigation (in Bunsen's Laboratory).

3. Improvement in the Clark Method for Determining the Hardness of Waters (in Baron Liebig's Laboratory while acting assistant there).

4. Cause of Mono-calcic Phosphate losing its Solubility.

5. On a Meteorite from Hartford County, Maryland (The above were published in *Ann. de Chem. und Pharm*).

S. Dana Hayes, Ph. D., State Assayer of Massachusetts, Boston.—Dr. Hayes is a working chemist, most of whose labors are necessarily hidden in cases in the United States courts, or remain unpublished as the property of those for whom they are made.

But he has found time to make the following contributions.

"A new Lead Salt corresponding to Cobalt Yellow." *Quar. Journ. Chem. Soc.*, and *Am. Journ. Sci. and Arts*, 1861.

"Ueber den Feldspath im geschmolzenen Zustande." *Pogg. Ann.*, Bd. III. S. 351.

"Influence of the Oxides of Chromium and Titanium

on the Composition of Pig-Iron." *Lond. Chem. News*, June, 1869.

"Adulterated Aniline Dyes." *Am. Suppl. to Chem. News*, May, 1870.

"Destructive Distillation of Light Petroleum Naphthas at comparatively Low Temperatures." *Am. Journ. Sci. and Arts*, 3, II. Sept. 1871.

"A common Source of Lead in Drinking Water."
"Assaying One Hundred and Thirty Years ago."
"Some New England Waters."
"Substitution of Soda for Potash in Plants."
} *Am. Chem.*, vol. i.

"History and Manufacture of Petroleum Products."
"Peculiar Conditions of Waters."
} *Am. Chem.*, vol. ii.

"Miscellaneous Chemical Notes," generally appertaining to industrial chemistry. *Am. Chem.*, vols. iii., iv., and v.

James M. Crafts, Professor of Chemistry in the Massachusetts Institute of Technology, Boston, Mass.—Mr. Crafts has made numerous researches, chiefly in organic chemistry. His published papers are as follows:—

1861. On the Action of Sulphite of Ammonium on Nitro-benzole (contributed in the name of Professor Carius).

In joint authorship with C. Friedel, Mr. Crafts made in the laboratory of Mr. Wurtz, in Paris, an elaborate investigation on new compounds of silicon with compound radicals, and on the atomic weight of silicon. Notices of these researches were published from time to time in the *Comptes Rendus* and elsewhere, but the final results were given in two memoirs in the *Ann. de Ch. et Phys.*, Paris, as follows:—

1866. Recherches sur les Éthers Siliciques et sur le Poids Atomique du Silicium. *Op. cit.*, 4me série, t. ix. pp. 5–51.

1870. Recherches sur les Combinaisons du Silicium avec les Radicaux Alcoholiques. *Op. cit.*, 4me série, t. xix. 334–367.

[These two memoirs are reproduced in the *Am. Journ. Sci.* [2], xliii. 155–171 and 331–344; xlix. 307–330.]

Mr. Crafts has also published separately in *Comptes Rendus*:—

Sur les Éthers des Acides de l'Arsenic.

Sur les Produits d'Oxydation du Sulfure d'Éthylène.

Sur le Sulfure d'Éthylène et sur une Combinaison qu'il forme avec le Brome.

In the *Am. Journ. Sci.* Prof. Crafts has published as follows:—

1863. Action of Bromine and of Bromhydric Acid on the Acetate of Ethyl, [2] xxxvi. 42.

1864. Note on the Product of the Reaction between the Monosulphide of Potassium and the Bromide of Ethylene, and on the several compounds derived from it, [2] xxxvii. 390.

1865. On the Replacement of one Alcohol Radical by another in Compounds of the Ether class (by C. Friedel and J. M. Crafts), [2] xl. 34.

1865. On Etherification (the same), p. 40.

1869. A Short Course of Qualitative Analysis, with the New Notation, with five Tables. New York. 12mo. 133 pages.

1873. The Estimation of Iron with Hyposulphite of Sodium. *Am. Chem.*, iii. July.

Henry M. Seely, Middlebury College, Vermont.—Professor Seely's papers have mostly been on topics not properly chemical, or have been in connection with some other person. We find, however, in the *Berkshire Medical Journal*, 1861, Art. XXXVI., entitled—

Report of a Chemical Analysis of Specimens of Hydrargyrum cum Creta, by Professor Seely, in which he notes the passage of finely-divided mercury, first into black and finally into red oxide of mercury.

John W. Langley, M.D., Professor of Chemistry, W. University of Pennsylvania, Pittsburgh, has published a paper entitled—

1862. On the Detection of Picrotoxine. *Am. Journ. Sci.*, xxxiv., 109, also in *London Medical News*.

B. F. Craig, M.D., Washington, D. C.—Dr. Craig has for some years been in charge of the laboratory of Army Medical Museum at Washington.

1861. On the Products from the Combustion of Gunpowder under different pressures. *Am. Journ. Sci.* [2], xxxi. 429.

1861. Report on Nitrification (presented to the Smithsonian Institution in 1858). *Smithsonian Report*, 1861, pp. 305–318.

1864. Remarks on the Production of the Combustion of Gun-Cotton and Gunpowder. *Ibid.*, 1864, pp. 232–234.

1871. Experiments on Ventilation and Composition of Air in Military Barracks. Appended to Surgeon-General Barnes's Report in "Circular No. 4," Washington, 1870. Noticed in *Am. Journ. Sci.* [3], i. 475.

1871. Variations in the Temperature of the Human Body. *Am. Journ. Sci.* [3], ii. 330.

Samuel P. Duffield, M.D., Ph.D., Dearbornville, Michigan.—Dr. Duffield's contributions are chiefly in the department of pharmaceutical chemistry, and are as follows:—

Remarks on Analysis of Brandy. *Am. Journ. Pharm.*, March, 1862.

Hypodermic Injections in their Relation to Toxicology. *Proc. Am. Pharm. Ass.*, 1866.

Report on New Remedies. *Detroit Review of Medicine*, 1866.

On Preparation of Pyrophosphate of Iron.

On Proportion of Digitalin in Digitalis grown in different Countries.

On Properties of the Leaves of Podophyllum Peltatum. *Proc. Am. Pharm. Ass.*, 1868.

Emanations from Sewers a Secret Cause of Disease. *Detroit Review of Medicine*. 1869.

On Medicinal Fluid Extracts. *Ibid.*, Nov. 1866.

On a Case of Aconite Poisoning. *Proc. Am. Pharm. Ass.*, 1870.

On the Geological Relation of the Mineral Waters of Michigan. *Detroit Review of Medicine*, 1871.

O. D. Allen, Professor of Metallurgy in the Sheffield Scientific School, New Haven, Connecticut.—Prof. Allen's researches on Cæsium and Rubidium, and the determination of the atomic weight of cæsium, are well known to all chemists. These memoirs are entitled:—

1862. Observations on Cæsium and Rubidium [in Contributions from the Sheffield Scientific Laboratory, Yale College, iv.]. *Am. Journ. Sci.*, xxxiv. 367–373.

1863. On the Equivalent and Spectrum of Cæsium [in Contributions from the Sheffield Scientific Laboratory, Yale College, v.]. Jointly with Prof. S. W. Johnson (q. v.). *Am. Journ. Sci.* [2], xxxv. 94–98.

Gideon E. Moore, Ph.D., Jersey City, New Jersey.—Dr. Moore has published the following original papers:—

1. On the Chemical Constitution of the Wax of the *Myrica cerifera*. *American Journal of Science* [2], xxxiii. 313, May, 1862.

2. On Brushite, a new Mineral occurring in Phosphatic Guano. *Proceedings* of the California Academy of Sciences, September 5, 1864. *American Journal of Science* [2], xxxix. 43.

3. On the Occurrence in Nature of Amorphous Mercuric Sulphide. *Journal für prakt. Chemie*, 1870. *American Journal of Science* [3], ii., January, 1872.

4. On the Electrolysis of the substituted Derivatives of Acetic Acid. *Ber. d. Deutschen chem. Gesellschaft*, May 22, 1871. *American Journal of Science* [3], iii., March, 1872.

P. Collier, A.M., Ph.D., Burlington, Vermont., Professor of Chemistry in the University of Vermont, has written chiefly on agricultural chemistry in the daily journals and for the State Agricultural Society, to which he is chemist.

1864. Indirect Determination of Potash and Soda. *Sill. Journ.* [2], xxxvii. 344.

J. M. Merrick, Boston, 59 Broad Street.—Mr. Merrick's papers are as follows:—

Inhalation of Vapor of Nitroglycerine. *Am. Journ. Sci.*, 1863.

Assay of Gold and Silver. *American Chemist*, vol. i., 1871.

Testing Cochineal. *American Chemist*, vol. i., 1871.
" Indigo. " " " "
Zinc Poisoning. " " " "

Assay of Pyrites for Gold. *American Chemist*, vol. ii., 1872.

Electrolytic Deposition of Nickel. *American Chemist*, vol. ii., 1872.

Separation of Nickel and Copper. *American Chemist*, vol. ii., 1872.

On the Double Chloride of Nickel and Ammonia. (Jointly with Isaac Adams, Jr.) *American Chemist*, vol. ii., 1872.

Electrolytic Determination of Copper. *American Chemist*, vol. iii., 1873.

Estimation of Tannin. *American Chemist*, vol. iii., 1873.

Note on Geissler Bulbs, etc. *American Chemist*, vol. iii., 1873.

Luckow's Method for Determining Copper. *American Chemist*, vol. iii., 1873.

Chemical Experts. *American Chemist*, vol. iv., 1873.
Analysis Crude Sugar. " " " "

Various Chemical Notes. *American Chemist*, vol. iv., 1874.

Estimation of Tannic Acid. *American Chemist*, vol. iv., 1874.

Numerous translations in *American Chemist*.

Analysis of Manures. *Chemical News*, xxiv.

Determination of Copper, Nickel, and Zinc. *Chemical News*, xxiv.

On a New Dye-stuff. *Chemical News*, xxv.
On Testing Cochineal. " " "

Various minor notes.

Charles Pierce, Cambridge.—Mr. Pierce's scientific memoirs are mostly mathematical or physical; but the following important paper falls within our scope:—

1863. The Chemical Theory of Interpretation. *Am. Journ. Sci.* [2], xxxv. 78.

Alexis A. Julien, School of Mines, Columbia College.

1864. On Metabrushite and other Guano Minerals, from Sombrero, W. I. *Am. Journ. Sci.* [2], xl. 367.

1870. On Examples for Practice in Quantitative Analysis. *Am. Chemist*, i. 256, 280. 322. 412.

On a supposed New Mineral from Chesterfield, Mass. *Am. Chemist*, i. 300.

1871. On the Proximate Analysis of Coals. *Am. Chem.*, i. 460.

Joseph Wharton, Philadelphia.—Mr. Wharton does not claim to be distinctly a chemist, but his contributions to the metallurgical arts closely related to chemistry demand respectful mention here, as well as one or two of his papers on other chemical and physical subjects. Mr. Wharton's principal labors have been the establishment in this country of the manufacture of metallic zinc or spelter, and of nickel and cobalt with their immediate products, though he has been largely engaged in lead, copper, iron, and steel.

That he has written little concerning nickel will not surprise those who consider that each of the very few nickel works in the world has to some extent its peculiar processes which cannot prudently be imparted to its rivals. Mr. W.'s nickel is remarkable for purity and uniformity, and comprises about one-sixth of the entire product of the world.

The following papers appear in the *Am. Journ. Sci.*, viz.:—

1865. xc. p. 190. Speculations upon a possible Method of determining the Distance of Certain Variably Colored Stars.

The diverse sensations caused by the several colors being due to the diverse numbers of light-wave impulses therefrom falling upon the retina, and those wave impulses being presumably longitudinal as well as lateral, rapid removal of the retina from the source of light should, by diminishing the number of wave impulses received (as rapid approach should by increasing the same) produce a corresponding change in the color perceived. Supposing the velocities of light answering to certain colors to have been ascertained by experiment, and a variably colored star with a determinable alternation of position to have been sought out—or, better, a pair of binary stars alternately eclipsing each other and of alternating colors—then measure the angle of greatest elongation of the line connecting those stars, and observe the time occupied by them in effecting a reversal of their positions—that is, in traversing a semi-circumference of their orbit: equal to $\frac{t}{2}$.

Assume the extreme colors to indicate a difference in the rate of arrival of light impulses, or, in other words, a difference in the velocity of light arriving from the stars when their entire orbital speed is of approach or recession to the spectator equal to $2v$.

Then their actual orbital speed $= v$, and, as the orbital period has been found $= t$, it follows that $\frac{v \times t}{3{\cdot}1416}$ is the real length of that diameter, which is the measured angular distance between the extreme positions of the stars. Knowing the angle and the length of the subtending base, we have the distance of the stars.

1869. xcvii. p. 251. Observations upon Autumnal Foliage. Conceiving that the autumnal change from green to red might be due to the acidifying influence of atmospheric oxygen upon the leaf sap after the vitality

of the leaf is lost or is destroyed by frost, thus enabling the thin acid sap to redden the vegetable blue element of the chlorophyl, Mr. W. undertook as a test of this supposition to reverse the process by immersing red autumn leaves in an alkaline atmosphere. The red leaves of sassafras, blackberry, maple, oak, etc., were restored to a green color, by leaving them under a bell-glass wherein ammonia was evaporating for periods of a few minutes, varying with the impermeability of the cuticle of the leaf.

1870. xcix. p. 365. On two Peculiar Products in the Nickel Manufacture. One of those products being basic crystals of iron, nickel, and cobalt sulphide, found in the matte furnaces of Gap Mine, having the unusual formula R_3S. The other being metallic bubbles or hollow spheroids formed on pouring melted nickel-copper alloy into water, the gases contained in a drop of metal sufficing to distend it into a bubble while cooling.

1871. cii. p. 168. Memoranda concerning the Introduction of the Manufacture of Spelter into the United States. This paper gives a detailed account of the establishment of this manufacture, with statements of materials consumed, cost, and product. After some preliminary experiments, Mr. W. erected at Bethlehem, Pa., in the year 1860, a spelter works of sixteen Belgian furnaces with all appurtenances, stipulated to produce 3,000,000 lbs. yearly, but which exceeded that quantity in 1861, and produced in 1862 over 3,700,000 lbs.

The zinc or spelter was of most excellent quality, and was made so cheaply as to afford a reliable profit, and to plant this industry firmly in this country.

The original features of the enterprise were: 1. The reduction to metal, on a large scale, of silicate of zinc, which had theretofore not been effected. 2. The successful application of anthracite to the manufacture of spelter, instead of the bituminous coal or wood which European practice had apparently shown to be indispensable. 3. The use of American clays for the making of zinc retorts.

Samuel D. Tillman, New York, 11 Cooper Union.—Mr. Tillman's contributions to chemical literature have been mainly in the department of chemical philosophy. His published papers are as follows:—

A New Chemical Nomenclature. See *Transactions of American Institute* for 1865–6, pp. 670–692. Applicable to more than 7000 bodies, each name indicating the exact composition of the body designated.

Chemical Diagrams and Derivative Symbols, illustrating the Prominent Characteristics of Chemical Elements. *Proceedings of the American Association for the Advancement of Science*, for 1867.

Atoms and Molecules. *Am. Chem.* for April, 1872 and *Nature* (London) for June, 1872.

Charles U. Shepard, Jr., M.D., Charleston, S. C.—Dr. Shepard has published the following memoirs:—

1866. On the Origin of Hippuric Acid in the Animal Organism. This is a small volume published in joint authorship with Prof. George Meissner, of Göttingen, Hanover, 1866.

1867. On the Change of Benzoic Acid in the Organism of Birds. *Zeitschrift der Ration. Medicin.*

1869. Notes on the Occurrence and Composition of Nodular Phosphates of South Carolina. *Am. Journ. Sci.* [2], xlvii. 354–364.

Dr. Shepard has published some other communications, the titles to which I have not been able to obtain.

James F. Babcock, Boston, Mass. (No. 8 Boylston St.), Boston University.—Prof. Babcock has published as follows:—

1866. On the Preparation of Sulphocyanide of Potassium. *Lond. Chem. News*, vol. xiv., 1866.

1866. On the Preparation of Iodide of Ammonium. *Proc. Am. Pharm. As.*, Philadelphia, 1866.

1867. On Beeswax. *Proc. Am. Pharm. As.*, Philadelphia, 1867.

1872. Reports on the Adulteration of Milk. *City of Boston*, 1870, 1871, 1872.

1873. On the Adulteration of Milk. *Report of the State Board of Health*, State of Massachusetts, 1873.

1874. On the Impurities of Commercial Iodide of Potassium. *The Laboratory*, Sept. 1874.

Report on the Preservation of Wood Pavements. *City of Boston*, 1873.

H. Carrington Bolton, Ph.D., School of Mines, Columbia College, New York.—All Dr. Bolton's contributions to chemistry fall within the last eight years. The following list does not embrace Dr. Bolton's latest contribution, for which he has placed us all under lasting obligations. I allude to his happy thought of memorializing the day we celebrate, for it is to him we owe the pleasure of this gathering at the grave of Priestley to-day.

1866. On the Fluorine Compounds of Uranium. Monatsb. der Berlin. Academie, 1866, p. 299. Also as pamphlet 40 pp.

1869. On the Action of Sunlight on Uranium. *Am. Journ. of Sci.*, Sept. 1869.

1870. Index to Literature of Uranium. Annals New York Lyc. Nat. Hist, vol. ix., p. 362.

History of the Defunct Elements. *Am. Chemist*, vol. i., p. 1.

Extraction of Uranium. *Ibid.*, vol. i., No. 2. August, 1870.

1872. Observations on the Platino-Cyanide of Magnesium. *Ibid.*, vol. ii., No. 10.

On Galvanic Action in the Mouth. *Dental Cosmos*, vol. xiv., p. 298.

1873. Washing Bottles a Cause of Fire. *Am. Chemist*, vol. iii., p. 286.

Views of the Founders of the Atomic Philosophy. *Ibid.*, vol. iii., p. 326.

With Prof. Henry Morton: Investigation of Fluorescent and Absorption Spectra of Uranium Salts. *Ibid.*, vol. iii., p. 361, *et seq.*

Zettnow's Scheme for Qualitative Analysis. *Ibid.*, vol. iii., p. 452.

Notes on the Early Literature of Chemistry. Four papers. *Ibid.*, vol. iv.

1874. Chemical Paradoxes. *Journ. of Appl. Chem.*, June, 1874.

Le Roy C. Cooley, Ph.D., Albany, New York—Prof. Cooley, of the State Normal School, has published the following:—

On Teaching Advanced Classes in Chemistry. Read at "University Convocation," etc., published in *Proc. of Third Anniv.*, 1866.

On Elementary Chemistry in Preparation for College. Read at "University Convocation," published in *Proc. of Fifth Anniv.*, 1868.

On a Steady Air-Blast for Laboratory Purposes. *Journ. Frank. Inst.*, vol. lxv., 1870.

On a Blowpipe Assay with the Automatic Air-Blast. *Ibid.*, vol. lxi., 1871.

On the Effect of the Action of Water on Gypsum. *Proc. Albany Inst.*, vol. i., Part I., 1870.

Report on the Progress of Chemistry, 1871. *Trans. of Albany Institute*, vol. vii.

"From Newton to Kirchoff" (sketch of spectrum analysis), 1872. *Ibid.*, vol. vii.

John M. Blake, New Haven, Connecticut.—Mr. Blake's contributions are chiefly mineralogical and physical. We note the following:—

1866. On Measuring Angles of Crystals.
1866. Gaylussite from Nevada.
1867. Natural Terpin.
1867. On Kaolinite and Pholerite.
1869. On Hortonolite.
All in the 2d series of the *Am. Journ. Sci.*

H. Endemann, Ph.D., New York. Dr. Endemann has contributed the following papers:—

1866. Die neutralen und sauren Aether der schwefligen Säure. *Annalen der Chemie und Pharmacie.*

1872. Meat and the Methods of Preserving it. *Am. Chemist*, January.

1869 to 1872. Disinfectants and Disinfection. Reports of the Health Department of the City of New York.

1872. Confectionery sold in the City of New York. Report of the Health Department of the City of New York.

1872. Examination of the Air in Schools, Manufactories, Tenements, Cellar Lodgings, Prisons, Theatres, and Public Halls in the City of New York. Report of the Health Department of the City of New York.

1873. Also another series. *New York World*, Dec. 27.

1872. Chemical and Mycological Examination of the Blood, Bile, and Urine of Horses sick with the Epizootic Influenza. Report of the Health Department of the City of New York.

1874. Warming and Ventilation. *Sanitarian*, April.

North Carolina Prisons. *Annals of the Lyceum of Natural History*, N. Y. vol. ix.

1874. Criticisms of Prof. Wurtz's Test for Free Oxygen in Water. *Am. Chemist*, July.

S. P. Sharples, Boston (114 State Street).—Mr. Sharples has published:—

1866. Chemical Tables. 8vo. pp. 192.

Papers in the *American Journal of Science*—

1868. On some Minerals from Chester County, Pennsylvania.

1869. On a New Salt, containing Tin, Calcium, and Chlorine (March).

1871. On some Dredgings from the Gulf Stream (February).

1871. On some Forms of the Galvanic Battery (April).

1874. Crystals of Zinc (March).

Papers in the *American Chemist*—

1872. The Waters of Eastern Massachusetts (November).

1873. The Disposal of Animal Refuse: and several shorter articles.

Papers in *Journal of Applied Chemistry*—

1873. On the Preservation of Food (August).

1874. On Common Salt (September).

Mr. Sharples has also, since 1871, been a constant contributor to the *Boston Journal of Chemistry*, of which journal he is assistant editor, having been previously (1866) a graduate of the Lawrence Scientific School, Cambridge; assistant (1867–8) at Lehigh University; assistant (1868–71) at Lawrence Scientific School; and (1872) State Assayer of Massachusetts. Dr. Sharples's Chemical Tables are in the hands of all American chemists.

George F. Barker, Professor of Physics in the University of Pennsylvania, Philadelphia, has published the following chemical and physical papers:—

Theoretical Chemistry.

On Normal and Derived Acids. *Am. Journ. Sci.*, Nov. 1867.

Formic *versus* Carbonous Acid. *Ibid.*, Sept. 1867.

On the Rational Formulas of the Oxides of Chlorine and of Oxides analogously constituted. *Am. Chem.*, July, 1871.

On Molecular Classification. *Ibid.*, April, 1871.

Physics.

Note on the Spectrum of the Aurora. *Am. Journ. Sci.*, Dec. 1871.

On the Aurora of October 14th, 1872. *Ibid.*, Feb. 1873.

Toxicology.

Report of a Trial for Poisoning by Strychnia. *Am. Journ. Med. Sci.*, Oct. 1864.

Testimony in the Sherman Poisoning Case. *Am. Chem.*, June, 1872.

Dr. Barker has also contributed valuable abstracts of chemical researches, chiefly from European journals in the *Am. Journ. Sci.*, since volume xlv. of the second series (1868). Also, a series of "Notices of papers in Physiological Chemistry." *Am. Journ. Sci.* [2], xlvi. 233–379; xlvii. 20. 258. 393; xlvii. 49.

"A Text-Book of Elementary Chemistry, Theoretical and Practical," 12mo., which has met deservedly with great favor as a clear exposition of the "New Chemistry."

The *Journal of the Franklin Institute* is now under the editorial care of Dr. Barker.

Edward W. Root.—The late Prof. Root, of Hamilton College, has published the following chemical papers:—

1867. "On Wilsonite from St. Lawrence County, N. Y." *Am. Journ. Sci.* [2], xlix. 47.

1868. "On Enargite from Mercury Star Mine, California." *Ibid.*, xlvi. 201.

Prof. Root died, in his 30th year, in November, 1871, highly esteemed for his scientific and literary attainments, integrity of character, and tested ability.

Beverly S. Burton, Ph.B., has published ("Contributions from the Sheffield Laboratory of Yale College, No. xvi.")—

1867. "Contributions to Mineralogy" with Analyses of: i. Enorgite from Colorado; ii. Argentiferous Jamesenite from the Sheba Mine, Star City, Nevada; iii. Argentiferous Tetrahedrite from the De Soto Mine, Nevada (the 2d and 3d collected in 1864 by B. Silliman). *Am. Journ. Sci.* [2], xlv. 34.

U. J. Knowlton, Rockport, Mass.—"On a New Mineral from Rockport, Mass." An altered zinc ore. *Am. Journ. Sci.* [2], lxix. 224. 1867.

S. F. Peckham, Minneapolis, Minnesota, University of Minnesota.—Professor Peckham's papers are:—

1867. On the Supposed Falsification of Samples of

California Petroleum. *American Journal of Science*, May, 1867.

1867. On a New Apparatus for Technical Analysis of Petroleum; together with Experiments upon the Formation of Asphaltum. *American Journal of Science*, September, 1867.

1868. Notes on the Origin of Bitumens. Read before the Natural Academy of Sciences, August, 1868. Published in the *Proceedings* of the American Philosophical Society, x., 441.

1869. On the Distillation of Dense Hydrocarbons at High Temperatures, technically termed "Cracking." *American Journal of Science*, January, 1869.

1869. On the Probable Origin of Albertite and Allied Minerals. *American Journal of Science*, November, 1869.

1871. Evaporating Niches at the Laboratory of the Maine State College of Agriculture and the Mechanic Arts. *American Chemist*, August, 1871. *Proceedings* of the American Association for Advancement of Science, 1871.

1873. American Asphalts. *American Chemist*, July, 1873.

Four reports to the State Geologist of California, which have been printed, but not yet published:—

1st. 1866. On the Oil Interests of Southern California.

2d. 1867. On the Results of a Technical Examination of California Bitumens.

3d. 1871. On the Results of an Examination of California and other Petroleums in Reference to their Ultimate Chemical Composition. Made at Cambridge in 1869.

4th. 1872. On the Results of Proximate Analyses of California and other Coals, and a Quantitative Determination of the Sulphur contained in them. Made in Providence in July, 1872. Also—

1873. Report to State Geologist of Minnesota in Report of Board of Regents of the State University of Minnesota.

1874. Peat for Domestic Fuel. Report to Geological Secretary of Minnesota, July, 1874.

P. CASAMAJOR, Williamsburg, New York.—Mr. Casamajor's papers, partly physical, partly chemical, are as follows:—

1867. On the Method of Measuring the Angles of Crystals by Reflection without the Use of a Goniometer. *American Journal of Science*, September.

1870. Action of Water on Lead. *American Chemist*, July.

1871. On the Purification of Sugar Solutions for the Optical Saccharometer. *American Chemist*, November.

1872. Researches on Voltaic Batteries. *American Chemist*, May, June, and July.

1873. Testing Sugar Solutions by Means of Areometers and the Optical Saccharometer. *American Chemist*, October and November.

1874. On the Formula of Francoeur for Correcting the Indications of Beaumé's Areometer into Corresponding Specific Gravities. *American Chemist*, February.

1874. New Portable Apparatus which may be used as a Filter Pump or Laboratory Bellows. *American Chemist*, April.

1874. On the Expansion of Sugar Solutions by Heat. *American Chemist*, June, 1874.

W. GOOLD LEVISON, Brooklyn, New York.—Mr. Levison has contributed the following papers:—

Letters on the Properties of Sodium Amalgam. Dated New York, June 11, 1867. Published in the *American Journal of Mining*, June 15, 1867, vol. iii., No. 12.

Letter on the Action of Sodium in the Pan. Dated New York, July 16, 1867. Published in the *American Journal of Mining*, July 20, 1867, vol. iv., new series, No. 3.

Paper on the Peat Deposits of Prospect Park. Read before the Natural History Department of the Long Island Historical Society, February 28, 1867.

Letter on an Improvement in Galvanic Batteries. Dated Cambridge, Massachusetts, May 1, 1870. Published in the *Journal of the Franklin Institute*, June, 1870, vol. lix., No. 6.

Paper on the Precipitation and Determination of the Metals of the Magnesian Group in the Form of Oxalates. Lawrence Scientific School Contributions, No. 12. *American Journal of Sciences*, September, 1870, vol. l., No. 149.

Note on an Improved Screw Cup and a New Connector for Volta-Electric Instruments. Read before the Lyceum of Natural History in the city of New York, November 11, 1872.

Note on the Production of Ammonia in Nitric Acid Batteries. Read before the Lyceum of Natural History in the city of New York, March 10, 1873. Published in the *Journal of the Franklin Institute*, May, 1873, vol. xlv. No. 5. Republished, with corrections, in the *Proceedings* of the Lyceum of Natural History for 1873.

Note on a Simple Connector for Battery Carbons. Read before the Lyceum of Natural History in the city of New York, April 13, 1874.

O. LOEW, Smithsonian Institution Laboratory, Washington, D. C.

Mr. Loew's contributions to chemistry are in the *Am. Journ. of Sci.*, as follows:—

1867. Action of Water on Carbo-Hydrates. [2], lxiii. 371.

1868. Ferrocyanide of Potassium on Monochloracetic Ether. [2], lxv. 383.

1868. Nitrate of Ammonia. [2], lxvi. 29.

1868. Bisulphid of Carbon in Sunlight. [2], lxvi. 363.

1869. Derivatives of tri-chlormethyl-sulphon-chlorid. lxvii. 350.

1870. Action of Sunlight on Sulphurous Acid. [2], lxix. 368.

1870. Ozone from Rapid Combustion. [2], lxix. 369.

1870. On Hydrogenium-amalgam. [2], l. 99.

1874. On Wheelerite, a New Fossil Resin. [3], vii. 571.

ISIDOR WALZ, Ph.D., New York, has published the following chemical papers:—

1868. On the Oxidation of Diamylene by means of Chromic Acid. *Sill. Am. Journ. of Sci.*, 2, xlv. 57.

1870. A Modification of Bunsen's Filtering Pump. *Chem. News*, 22, 163.

Notes on the Extinctive and Reducing Powers of Mercury. *Ibid.*, 22, 217.

1870. On the Reduction of Sulphuric Acid by Zinc Amalgam. *Amer. Chemist*, i. 242.

1870. On the Reaction of Chloral Hydrate and Sulphide of Ammonium. *Ibid.*, i. 441.

1871. Determination of Moisture in Bone-black. *Ibid.*, ii. 169.

1872. On the Action of Chromium Trioxide on Iodine. *Ibid.*, iii. 84.

1873. On Antimony Terchloride as a Reagent for Oils. *Ibid.*, iv. 169.

A series of articles "On Chemistry applied to Textile Arts and Dyeing," of which eighteen chapters have appeared in *The Manufacturer's Review and Industrial Record* since 1872, and which, when finished, will be collected in a volume.

Frank W. Clarke, S.B., University of Cincinnati, O.—Prof. Clarke has made the following contributions to chemistry:—

1868. On New Processes in Chemical Analysis. *Am. Journ. Sci.*, xlv. 173.

1869. Upon the Atomic Volume of Liquids. *Am. Journ. Sci.*, xlvii. 180.

1869. Upon the Atomic Volume of the Elements. *Am. Journ. Sci.*, xlvii. 308.

1869. A Qualitative Separation of Cobalt and Nickel. *Am. Journ. Sci.*, xlviii. 67.

1870. On a New Method of Separating Tin from Arsenic, Antimony, and Molybdenum. *Am. Journ. Sci.*, xlix. 48.

1870. On the Atomic Volume of Solid Compounds. *Am. Journ. Sci.*, l. 174.

1870. An Examination of the Doctrine of Atomicity. *Am. Chem.*, November.

1873. Evolution and the Spectroscope. *Pop. Sci. Month.*, Jan.

1874. The Constants of Nature; Smithsonian Miscellaneous Contributions, Part I.; Specific Gravities; Boiling and Melting-points; and Chemical Formulæ, pp. 203. 8vo. *Smith. Inst.*

1874. On the Molecular Volume of Water of Crystallization, and—

1874. On the Molecular Heat of Similar Compounds. *Am. Jour. Sci.* [3], viii.

W. G. Mixter, Instructor in Chemistry, Sheffield Scientific School, Yale College.—Mr. Mixter's chemical papers are:—

1868. "On Nillemite and Tephroite" (from Mine Hill, Sussex, New Jersey, with Analyses). *Am. Journ. Sci.* [2], xlvi. 230.

1872. "On the Estimation of Sulphur in Coal and Organic Compounds." *Ibid.* [3], iv. 90.

1873. In connection with E. S. Dana, "On the Specific Heat of Zirconium, Silicon, and Boron." *Ann. Chem. u. Pharm.*, Bd. 195, 388, and *Am. Journ. Sci.* [3], 506, Abstract.

William H. Chandler, Professor of Chemistry in the Lehigh University, Bethlehem, Pennsylvania, has published the following chemical papers:—

The Economical Purification of Zinc, containing Iron. *American Supplement to American Reprint of Chemical News*, Sep. 1869, p. 193.

On the Determination of Sulphur Compounds in Mineral Waters. *Ibid.*, April, 1870, p. 221.

Production of Iodine and Bromine. *Am. Chem.*, vol. i. p. 47.

Carbon Photographs. *Ibid.*, vol. i. p. 94.

The Sherman Process for Refining Iron. *Ibid.*, vol. i. p. 366.

The Peruvian Guano Islands. *Ibid.*, vol. i. p. 439.

A Day in Dublin. *Ibid.*, vol. ii. p. 88.

Henry Morton, LL.D., President of Stevens Institute of Technology, Hoboken, New Jersey.—Most of Prof. Morton's papers are more properly physical than chemical, but the following fall within our scope.

1869. Research on the bright line beyond the Moon's Edge, in partial phase eclipse photographs. *Comptes Rendus, French Acad.*, V. lxix. p. 1234. Also *Journ. Frank. Inst.*, lviii. 373.

This research demonstrated that this phenomenon was a result of chemical reaction, a "local re-development" of the image, as Dr. Morton called it, and that consequently the views of Airy and Prest. Barnard, that it was either subjective or from diffraction, was no longer tenable.

1872. Researches on Anthracene and Chrysogen. *Am. Chemist*, Sept., and *Phil. Mag.*, Sept., p. 345.

1872. Research on Certain New Solid Hydrocarbons in Petroleum Distillates, "Thallene and Petrollucene." *Am. Chemist*, Nov., and *Phil. Mag.*, V. xlvi. p. 89, *Revue Scientifique, Chem. News*, etc.

1872–73. On Fluorescent and Absorption Spectra of Uranium Salts, a series of papers running through the *Am. Chemist*, vols. iii. and iv. In joint authorship with Dr. H. Carrington Bolton.

1873. On Basic Salts of Uranium. *Am. Chemist*, iv. 125; also *Revue Scientifique*, etc.

1874. On Pyrene and Chrysene. *Am. Chemist*, current Nos.

Rossiter W. Raymond, Ph.D., New York City.

1869. Dr. Raymond's Annual Reports as U. S. Commissioner of Mines since 1869 have been an important contribution to technical literature, and especially to metallurgists.

Dr. Raymond has also established the *Engineering and Mining Journal*, which for about ten years has been a principal authority in all chemical matters relating to the smelting and assay of ore, and has done a good work for practical science generally. One who is absorbed by such editorial labors finds little time for original research, but Dr. Raymond has contributed an important memoir upon the Tertiary and Cretaceous lignites of Western America, entitled—

1873. Calorific Value of the Lignites of Western America. *Engineering and Mining Journal*, and *Am. Journ. Sci.* [3], vi. 220.

Albert H. Gallatin, M.D., 10 E. 17th Street, New York.—The only original paper by Dr. Gallatin which I have seen is entitled—

On Hydrogenium Alloys. *Phil. Magazine*, London, July, 1869.

Paul Schweitzer, Ph.D., Professor of Chemistry, Columbia, Boone County, Missouri, has published the following chemical papers:—

I. On Tribasic Phosphoric Acid; its history, its modes of separation from sesquioxides, principally sesquioxide of iron, and its estimation. *Annals of the Lyceum of Natural History of New York*, vol. ix. Nos. 5 and 6, 1869.

II. On the Quantitative Separation and Determination of Iodine, Bromine, and Chlorine. *Chemical News*, American reprint, vol. v. p. 317, 1869.

III. The Various Methods for the Determination and Separation of Baryta, Strontia, and Lime; also, some Remarks on the Precipitation of Sulphuric Acid by Salts of Baryta (five papers). *Chemical News*, American reprint, vol. vi. pp. 119, 222, 295, 370, 1869; *Am. Chem.*, vol. i. p. 9, 1870.

IV. Analyses of Pure Lead. *Proceedings of the Lyceum of Natural History of New York*, p. 8, 1870.

V. Kresol and Phenol and their Homologues. *Am. Chem.*, vol. i. p. 239, 1871.

VI. Notice of a Curious Boiler Deposit. *Am. Chem.*, vol. i. p. 287, 1871.

VII. On the Action of Sulphurous Acid on Metals. *Am. Chem.*, vol. i. p. 296, 1871.

VIII. Notes on the Feldspathic Sandstones (Felsites) of the Palisade Range. *Am. Chem.*, vol. ii. p. 23, 1871.

IX. Contributions to the Mineralogy of Manhattan Island. *Am. Chem.*, vol. iv. p. 443, 1874.

X. Columbia Chalybeate Spring. *Report University of Missouri*, 1874, p. 160.

XI. On the Water Supply of the Town of Columbia. *Report University of Missouri*, 1874, p. 161.

XII. Action of Rain-Water on Lead Pipes. *Report University of Missouri*, 1874, p. 163.

Wm. Ripley Nichols, Professor of Chemistry at the Massachusetts Institute of Technology, Boston, has published:—

On the Chromites of Magnesium. *Am. Journ. Sci.*, xlvi. 16, 1869.

On the Composition of the Acid Oxalates of Potassium, Ammonium, and Sodium. *Proc. Am. Assoc.*, xviii. (1869), 159.

On the Solubility in Water of the Oxalates of Sodium, Potassium, and Ammonium. *Proc. Am. Assoc.*, xviii. (1869), 163.

Report on the Action of Cochituate Water on Lead Pipes. *Mass. State Board of Health, 2d Annual Report*, 1871, p. 32.

In connection with Geo. Derby, M.D.:—

Sewerage; Sewage; The Pollution of Streams; The Water Supply of Towns. A Report to the State Board of Health of Massachusetts. *Mass. State Board of Health, 4th Annual Report*, 1873, p. 12.

On the Present Condition of Certain Rivers of Massachusetts, together with considerations touching the water supply of towns. *Mass. State Board of Health, 5th Annual Report*, 1874, p. 61.

J. Blodgett Britton, Philadelphia.—In his capacity of Chemist to the "Iron Masters' Laboratory" 339 Walnut Street, Philadelphia, Mr. Britton has performed a great amount of technical work in the Analysis of Iron Ores, Furnace Products, etc. etc., which need not be given in detail here. But the following papers come properly in as contributions to chemistry.

1870. 1st. "A Method for determining quickly and accurately the Amount of Chromium and Iron in Chrome Iron Ores." *Journal Franklin Institute* for March, 1870.

2d. "Mounted Burettes for Volumetric Analysis." *Journal Franklin Institute* for May, 1870.

3d. "The Determination of Combined Carbon in Iron and Steel by the Colorimetric Process." *Journal Franklin Institute* for May, 1870.

Albert B. Prescott, Professor of Applied Chemistry, University of Michigan, Ann Arbor, Michigan, has contributed as follows to our chemical literature:—

Simple Apparatus for Rapid Vaporization at limited heat under reduced pressure without use of pump. *Chem. News*, xx. 222 (1870).

On Sulphophenic Acid. *Proc. Am. Pharm. As.*, xix. 550 (1871).

And in joint authorship with Prof. Silas H. Douglass, Prof. Prescott has published—

Qualitative Chemical Analysis, a guide in the practical study of chemistry, and in the work of analysis. 8vo. pp. 260. 1872.

Arnold D. Hague, New York.—Mr. Hague, who has long been connected with the United States Geological Exploration of the 40th Parallel, is the author of a paper—

1870. On the Chemistry of the Washoe Process of Amalgamation. This paper forms part of vol. iii. "Mining Industry" of the Reports of the United States Geological Exploration of the 40th Parallel, 4to. 1870.

Samuel P. Sadtler, Professor of General Chemistry in the University of Pennsylvania, Philadelphia, has published the following papers on chemistry:—

On Potassio-cobaltic Nitrites, with analogous and related compounds. *Am. Journ. Sci.*, March, 1870.

On some Iridium Salts. *Inaugural Dissertation*, Göttingen, April, 1871.

Abstract of the same Work. *Am. Journ. Sci.*, Nov. 1871.

Analytical Notices of New Processes. *Am. Journ. Sci.*, March, 1874.

J. M. Silliman, Lafayette College, Easton, Pa.—Prof. Silliman has published—

1870. Examination of the Bessemer Flame with Colored Glasses, and Spectroscopic Examination of the Bessemer Flame. *Am. Journ. Sci.*, l. 297, and *Proc. Am. As.*, xix. 119.

Sidney A. Norton, Columbus, Ohio, Ohio Agricultural and Mechanical College.

1870. "On a Bichloride of Platinum + $5H_2O$." This salt is less deliquescent than the ordinary salt, and is a new form. *Journ. fur Prakt. Chem.*, Bd. 2, S. 469.

1872. A second paper on the same. *Ibid.* Bd. 5. S. 365.

Richard H. Lee has published ("Contributions to Chemistry from the Laboratory of the Lawrence Scientific School, No. 16") an important paper, entitled—

1871. "On the Atomic Weights of Cobalt and Nickel." *Am. Journ. Sci.* [3], ii. 44.

Thomas M. Chatard has published ("Contributions to Chemistry from the Laboratory of the Lawrence Scientific School, No. 15") a valuable contribution—

1871. "On some New Analytical Methods: § 1. On the Determination of Molybdic Acid as Plumbic Molybdite. § 2. On the Evaporation to Dryness of Gelatinous Precipitates (a former paper of M. Chatard's on this subject is printed in *ibid.* i. 247). § 3. Tests for Nitrous Acid. § 4. On the Determination of Small Quantities of Manganese." *Am. Journ. Sci.* [3], i. 416.

Charles E. Munroe, Professor of Chemistry, etc., U. S. Naval Academy, Annapolis, Md.—Prof. Munroe has published:—

"On the Estimation of Phosphoric Acid." *Am. Journ. Sci.* [2], i. 359. 1871.

"On the Use of a Porous Cone in Filtration." *Ibid.* 336. Also reproduced in Fresenius' *Zeitschrift.*

Elwyn Waller, School of Mines, Columbia College, New York.—Mr. Waller has published:—

1872. Notes on the Petroleum of St. Domingo. *Am. Chem.*, ii. 220.

1872. Application of Osmose to Purification of Sugars. *Ibid.*, iii. 139.

1872. Coal Tar Colors. *Ibid.*, ii. 9.

Also, in the Report of the New York Board of Health for 1872:—

Report on the Croton Water, for the year 1872.

Report on Baking Powders, etc.

Report on Disinfection and Disinfectants. A paper read before the American Public Health Association, November, 1873.

Carbolic Acid, Tests of its Presence, and a New Method for its Quantitative Estimation. *Sanitarian*, November, 1874.

Mr. Waller, as one of the editors of the *American Chemist*, is a constant contributor, by his abstracts of chemical literature, foreign and domestic.

Edwin J. Houston, Philadelphia, Pennsylvania, has contributed the following original memoirs:—

On the Change of Color produced in Certain Chemical Compounds by Heat. *Journal of the Franklin Institute*, vol. lxii., No. 2, August, 1871.

Color Changes produced in Chemical Compounds by Solution. (Unpublished.) Read before the Optical Section of the Franklin Institute during the winter of 1872.

On the Nature of White Light. *Journal of the Franklin Institute*, 1873.

On the Artificial Production of Cold. *Journal of the Franklin Institute*, 1873.

On a Supposed Allotropic Modification of Phosphorus. *American Phil. Society Proceedings.* Read January, 1874.

Prof. Elihu Thomson, of Philadelphia, was jointly associated in the first and last of the above investigations.

Arthur W. Wright, New Haven.—Dr. Wright, Professor of Chemistry and Molecular Physics at Yale College, is the author of important researches in physics. The following are his chemical contributions:—

1. On a simple Apparatus for the Production of Ozone with Electricity of High Tension. *Am. Journ. Sci.*, iii. vol. iv., July, 1872.

2. On the Action of Ozone upon Vulcanized Caoutchouc. *Ibid.*

3. On the Oxidation of Alcohol and Ether by Ozone. *Ibid.*, vol. vii., March, 1872.

A. Emerson Dolbear, Bethany, West Virginia.—Prof. Dolbear's contributions to chemistry are—

1872. A Method of obtaining Potassium. *American Chemist*, February, 1872.

1874. On the Use of Iron Sulphide as a Disinfectant and Deodorizer. *Scientific American.*

A. E. Foote, Professor of Chemistry in the Iowa State Agricultural College, Ames, Iowa, has published as follows:—

1872. Zeonochlorite, a new hydrous silicate from Nupigon Bay, north shore of Lake Superior. *Am. As. Proc.*, 1872; republished in *Am. Chem.*, vol. p.

1873. A Modification of the (Jagn) Vacuum or Filter Pump, that can be used with from three to five feet fall of water, and does not easily get out of repair. *Proc. Am. As.*, 1873, p. 141; also *Am. Journ. Sci.*, 3d ser., vi. 360; and likewise *Am. Chem.* and *Journ. Frank. Inst.*

E. S. Dana, Yale College, New Haven, Conn., has contributed as follows:—

"On the Composition of the Labradorite Rocks from Waterville, N. H." *Am. Journ. Sci.* [3], vol. iii. 48.

Also the following mineralogical and physical papers:—

"On Datolite from Bergen Hill." *Am. Journ. Sci.* [3], vol. iv. p. 16. 1872.

"On Datolite." *Tschermak's Mineralogische Mittheilungun*, i. 1874.

"On a Remarkable Crystal of Andalusite." *Am. Journ. Sci.* [3], vol. iv. p. 473.

"On Atacamite." *Tschermak's Mineralogische Mittheilungen*, i., 1874.

"On the Thermo-electrical Properties of some Minerals." *Am. Journ. Sci.* [3], vol. viii. p. 255.

"On the Trap Rocks of the Connecticut Valley." *Am. Journ. Sci.* [3], vol. viii. p. 390.

And in company with W. G. Mixter, of the Sheffield Scientific School—

"On the Specific Heat of Zirconium, Silicon, and Boron." *Ann. Chem. u. Pharm.*, vol. clix. p. 388.

Albert R. Leeds, Professor of Chemistry, Stevens Institute of Technology, Hoboken, New Jersey, has contributed as follows:—

1873. Contributions to Mineralogy with analyses of: I. A Hydrous Unisilicate approaching Pyrosclerite. II. Talc Pseudomorphous after Pectotile. III. Leucangite from Amity, N. Y. IV. Mineral associated with Corundum and approaching Ripidotile. V. Moonstone from Media, Delaware County, Pa. VI. Anthophyllite from the "Star Rock," Concord, Delaware Co., Pa. VII. Wernerite from Van Arsdale's Quarry, Bucks Co., Pa. *Am. Journ. Sci.* [3], vi. 22.

Spectroscopic Examination of Silicates. *Am. Chem.*, vol. iii. 446.

Blake Crusher for Laboratory Use. *Ibid.* 453.

On the Volumetric Determination of Chlorine with Standard Silver Solution and Potassic Chromate. *Ibid.* 290.

1874. On the Dissociation of Certain Compounds at very low Temperature. *Am. Journ. Sci.* [3], vii. 197.

On the Purification of Mercury. *Am. Chemist*, vol. iv. 309.

Upon Alizarin as a Test. *Ibid.* 333.

Upon the Alteration of Albite and the Genesis of Deweylite. *Ibid.* 164.

The Student's Practical Chemistry. In connection with Prof. H. Morton. 1865.

Chemical Notes, Reviews, and Experiments. *Jour. Franklin Institute*, 1867–1871.

Gasometer for Accurate Measurements. *Jour. Franklin Institute*, 1868.

Chemical Tables according to the Theories of Modern Chemistry. *Jour. Franklin Institute*, 1870, and *Chemical News.*

Analysis of some hitherto Undetermined Minerals. *Jour. Franklin Institute*, 1870.

On the Spectra of Certain Metallic Compounds. *Jour. Franklin Institute*, 1870, and *Quarterly Journal of Science.*

On Aventurine Orthoclase. *Amer. Jour. Sci.*, 1872.

Ira Remsen, Professor of Chemistry, Williams College, Williamstown, Mass.—Prof. Remsen has contributed the following important papers:—

1870. "Uber die Homologen des Naphtalins." *Liebig's Annalen.*

"Investigations on Piperic Acid" (Dissertation for Degree of Ph.D. at the University of Göttingen).

1871. "Ueber eine neue Darstellungsmethode der Paraoxbenzœsäure." *Zeitschrift für Chemie.*

"Ueber die Constitution der Protocatechusäure." *Ibid.*

"Ueber Parasulfobenzœsäure." *Ibid.*

1872. "Weitere Untersuchungen über die Constitution der Piperinsäure." *Liebig's Annalen.*

1873. "Investigation on Parasulphobenzoic Acid." *Am Journ. Sci.* [3], pp. 179–186; *Ibid.*, 274–282, and 354–362. Prof. Remsen has also published a translation. *Am. Journ. Sci.*

"On Isomeric Sulphosalycylic Acids." *Am. Journ. Sci.*

1874. "On the Formation of Paratoluic Acid from Parasulphotoluenic Acid." *Ibid.*

"On Nitroparasulphobenzoic Acid." *Ibid.*

"On the Action of Potassium upon Ethyl Succinate." *Ibid.*

In 1873 he edited Fittig's Wöhler's "Outlines of Organic Chemistry;" with additions. Prof. Remsen also furnishes abstracts and articles of the *Berichte der deutschen Chem. Gesellschaft* for each number of the *American Chemist.*

W. C. MAY has published ("Chemical Papers from the Massachusetts Institute of Technology, No. 11")—

1873. "On the Determination of Lead as Peroxide." *Ibid.* [3], vi. 255.

H. B. CORNWALL, E.M., Professor of Mineralogy and Chemistry in the John C. Green Scientific School, College of New Jersey, Princeton, has contributed papers—

1873. On the Occurrence of Indium discovered in American Blendes. *Am. Chemist*, January.

A Quantitative Analysis of Roxbury Blende. *Am. Chemist*, October.

We are also indebted to Prof. Cornwall for his excellent translation of—

1872. Plattner's Manual of Qualitative and Quantitative Analysis with the Blowpipe. From the last German Edition, etc. N. Y.: D. Van Nostrand. 8vo. pp. 548. And—

1873. A second edition of the above.

F. M. F. CAZIN, M.E., Denver, Colorado.—Mr. Cazin has published a paper entitled—

1873. Fluor Spar in its application in the Cupola Furnace, and in the Puddling and Bessemer Process. *Berg. und huetten Marnnsch Zeit.*, xxxii. No. 15.

REGIS CHAUVENET and A. A. BLAIR, St. Louis, Mo., have published, in joint authorship—

Chemical Analyses of the Coals, Iron Ores, and Iron of Missouri. 8vo. pp. 1873, N. Y. Extracted from the Report of the Geological Survey of Missouri. 1873.

WILLIAM J. LAND, Atlanta, Georgia.—Mr. Land has published the following contributions in the *American Chemist*, vol. iii.:—

Determination of Hydrosulphuric Acid in Mineral Waters.

Improved Atmospheric Washing Bottle for the Use of Analytical Chemists.

Improved Apparatus for General Gasmetry (with a drawing).

He has also published in Georgia—

Analysis of the Ash of the Cotton Plant, etc.

Analysis of the Ash of the Cotton Seed.

A. P. S. STUART, Professor of Chemistry, Illinois Industrial College, Champaign, Illinois, has published as follows:—

1. In the third and fourth *Reports of the Illinois Industrial University*—

On the Organic Matter of Soils.

On the Origin and the Physical and Chemical Properties of the Inorganic Matter of Soils.

2. In the *Prairie Farmer*—

On the Influence of Light in the Growth of Plants.

3. In the *Transactions of the Illinois State Horticultural Society*—

On the Distribution of Nitrous Acid in Plants.

On the Use of a Glazed Wrought-iron Tube for Nitrogen Determinations.

WM. MCMURTRIE, Washington, D. C.—In his capacity of Chemist to the Department of Agriculture, Mr. McMurtrie has contributed a number of interesting researches, the results of which are embraced in the Monthly Reports of that Department for 1873–4. These are chiefly analyses of fertilizers, corn, wines, soils, etc., which are important additions to agricultural knowledge.

CHARLES A. BRINLEY, Midvale Steel Works, near Philadelphia.—Mr. Brinley's paper, "Notes on a Charcoal Furnace" (*Am. Chem.*, iii. No. 1), contains some analyses of iron and furnace products.

E. S. BREIDENBAUGH has published ("Contributions from the Sheffield Laboratory of Yale College, No. 27") a valuable research with numerous analyses—

1873. "On the Minerals found at the Tilly Foster Iron Mines, New York." *Am. Journ. Sci.* [3], vi. 207. This locality proves to be one of the most interesting chapters in American mineralogy, furnishing the material for Prof. Dana's paper, "On Serpentine Pseudomorphs and other Kinds" (Nov. 1874), and a wonderful development of new crystalline forms of Chendrodite now under examination by Mr. Edward S. Dana.

EDWARD W. MORLEY, Professor of Chemistry, Western Reserve College, Hudson, Ohio.—Professor Morley has described—

"An Apparatus for Rapid Filtration." *Am. Jour. Sci.* [3], vi. 214. 1873.

C. W. HINMAN, B.S., Boston, Mass.—Mr. Hinman has just published Description of a new Apparatus for Gas Analysis. *Sill. Journ.* [3], viii. 182. Sept., 1874.

HENRY WURTZ.—A considerable number of the contributions of this chemist we find have been overlooked in the former list (see pp. 109, 110). To some of these he has called our attention, as follows:—

1868. On Some New Chemical Relations of Metallic Aluminum. *Am. Association at Chicago, in* 1868, p. 196.

1869. Studies in Chemical Geogony. Three subjects: 1. On the Prozoic Atmosphere, and the Ocean of the Zoic Dawn. 2. Zoic History, from a Chemical View-Point. 3. Chemical Revelation of a Final Zoic Catastrophe. *Am. Association at Salem*, 1869, pp. 217, 223, 225.

1872. Lithology of the Rocks of the Palisade Range. *Am. Chemist*, Jan. 1872, p. 258.

1872. Some Chemi-Genetic Views regarding the Past and the Future. *Am. Chemist*, April, 1872, p. 385.

1873. Chemical and Sanitary Report upon the Passaic River. *Am. Chemist*, Sept. 1873, p. 99, and Oct. 1873, p. 133.

1874. Second Chemical and Sanitary Report upon the Water Supply of the Cities of Newark and Jersey City. *Am. Chemist*, March, 1 74, p. 323.

1874. Subaerial Oxygenation of Waters. *Proceedings of N. Y. Lyceum of Natural History*, Feb. 1874.

1874. Discussion of the above Subject with Dr. H. Endemann. *Am. Chemist*, July, 1874, pp. 9, 10.

PRIESTLEY'S NARRATIVE OF HIS DISCOVERY OF OXYGEN.

Extracted for the American Chemist, by Albert H. Gallatin, M.D.

Experiments and Observations on different kinds of Air. By Joseph Priestley, LL.D., F.R.S., 2d edition. London, 1776, vol. i. sect. iii.

Of Dephlogisticated Air, and of the Constitution of the Atmosphere. Pp. 1–24; pp. 29–41.

The contents of this section will furnish a very striking illustration of the truth of a remark which I have more than once made in my philosophical writings, and which can hardly be too often repeated, as it tends greatly to encourage philosophical investigations, viz., that more is owing to what we call *chance*, that is, philosophically speaking, to the observation of events arising from unknown causes, than to any proper design or preconceived theory in this business. This does not appear in the works of those who write synthetically upon these subjects; but would, I doubt not, appear very strikingly in those who are the most celebrated for their philosophical acumen, did they write analytically and ingenuously.

For my own part, I will frankly acknowledge, that, at the commencement of the experiments recited in this section, I was so far from having formed any hypothesis that led to the discoveries I made in pursuing them, that they would have appeared very improbable to me had I been told of them; and when the decisive facts did at length obtrude themselves upon my notice, it was very slowly, and with great hesitation, that I yielded to the evidence of my senses. And yet, when I reconsider the matter, and compare my last discoveries relating to the constitution of the atmosphere with the first, I see the closest and the easiest connection in the world between them, so as to wonder that I should not have been led immediately from the one to the other. That this was not the case I attribute to the force of prejudice, which, unknown to ourselves, biases not only our *judgments*, properly so called, but even the perceptions of our senses; for we may take a maxim so strongly for granted, that the plainest evidence of sense will not entirely change, and often hardly modify our persuasions; and the more ingenious a man is, the more effectually he is entangled in his errors; his ingenuity only helping him to deceive himself, by evading the force of truth.

There are, I believe, very few maxims in philosophy that have laid firmer hold upon the mind, than that air, meaning atmospherical air (free from various foreign matters, which were always supposed to be dissolved, and intermixed with it), is a *simple elementary substance*, indestructible and unalterable, at least as much so as water is supposed to be. In the course of my inquiries, I was, however, soon satisfied that atmospherical air is not an unalterable thing; for that the phlogiston with which it becomes loaded from bodies burning in it, and animals breathing it, and various other chemical processes, so far alters and depraves it, as to render it altogether unfit for inflammation, respiration, and other purposes to which it is subservient; and I had discovered that agitation in water, the process of vegetation, and probably other natural processes, by taking out the superfluous phlogiston, restore it to its original purity. But I own I had no idea of the possibility of going any further in this way and thereby procuring air purer than the best common air. I might, indeed, have naturally imagined that such would be air that should contain less phlogiston than the air of the atmosphere; but I had no idea that such a composition was possible.

It will be seen in my last publication that, from the experiments which I made on the marine acid air, I was led to conclude that common air consisted of some acid (and I naturally inclined to the acid that I was then operating upon) and phlogiston; because the union of this acid vapor and phlogiston made inflammable air; and inflammable air, by agitation in water, ceases to be inflammable, and becomes respirable. And though I could never make it quite so good as common air, I thought it very probable that vegetation, in more favorable circumstances than any in which I could apply it, or some other natural process, might render it more pure.

Upon this, which no person can say was an improbable supposition, was founded my conjecture, of volcanoes having given birth to the atmosphere of this planet, supplying it with a permanent air, first inflammable, then deprived of its inflammability by agitation in water, and further purified by vegetation.

Several of the known phenomena of the *nitrous acid* might have led me to think that this was more proper for the constitution of the atmosphere than the marine acid; but my thoughts had got into a different train, and nothing but a series of observations, which I shall now distinctly relate, compelled me to adopt another hypothesis, and brought me, in a way of which I had then no idea, to the solution of the great problem, which my reader will perceive I have had in view ever since my discovery that the atmospherical air is alterable, and, therefore, that it is not an elementary substance, but a *composition*, viz., what this composition is, or *what is the thing that we breathe*, and how is it to be made from its constituent principles.

At the time of my former publication I was not possessed of a *burning lens* of any considerable force; and for want of one I could not possibly make many of the experiments that I had projected, and which, in theory, appeared very promising. I had, indeed, a *mirror* of force sufficient for my purpose. But the nature of this instrument is such that it cannot be applied with effect, except upon substances that are capable of being suspended or resting upon a very slender support. It cannot be directed at all upon any substance in the form of *powder*, nor hardly upon anything that requires to be put into a vessel of quicksilver; which appears to me to be the most accurate method of extracting air from a great variety of substances, as was explained in the introduction to this volume. But having afterwards procured a lens of twelve inches diameter, and twenty inches focal distance,* I proceeded with great alacrity to examine, by the help of it, what kind of air a great variety of sub-

Fig. *a*.

stances, natural and factitious, would yield, putting them into the vessels represented (fig. *a*), which I filled

* This lens was preserved in the Smithsonian Institution, Washington, D. C., previous to the destructive fire of 1865. Eds.

with quicksilver and kept inverted in a basin of the same. Mr. Warltire, a good chemist and lecturer in natural philosophy, happening to be at that time in Calne, I explained my views to him, and was furnished by him with many substances which I could not otherwise have procured.

With this apparatus, after a variety of other experiments, an account of which will be found in its proper place, on the 1st of August, 1774, I endeavored to extract air from *mercurius calcinatus per se;* and I presently found that by means of this lens air was expelled from it very readily. Having got about three or four times as much as the bulk of my materials, I admitted water to it and found that it was not imbibed by it. But what surprised me more than I can well express, was, that a candle burned in this air with a remarkably vigorous flame, very much like that enlarged flame with which a candle burns in nitrous air exposed to iron or liver of sulphur; but as I had got nothing like this remarkable appearance from any kind of air besides this particular modification of nitrous air, and I knew no nitrous acid was used in the preparation of *mercurius calcinatus*, I was utterly at a loss how to account for it.

In this case, also, though I did not give sufficient attention to the circumstance at that time, the flame of the candle, besides being larger, burned with more splendor and heat than in that species of nitrous air; and a piece of red-hot wood sparkled in it exactly like paper dipped in a solution of nitre, and it consumed very fast; an experiment which I had never thought of trying with nitrous air.

At the same time that I made the above-mentioned experiment, I extracted a quantity of air, with the very same property, from the common *red precipitate*, which being produced by a solution of mercury in spirit of nitre, made me conclude that this peculiar property, being similar to that of the modification of nitrous air above mentioned, depended upon something being communicated to it by the nitrous acid; and since the *mercurius calcinatus* is produced by exposing mercury to a certain degree of heat, where common air has access to it, I likewise concluded that this substance has collected something of *nitre*, in that state of heat, from the atmosphere.

This, however, appearing to me much more extraordinary than it ought to have done, I entertained some suspicion that the mercurius calcinatus, on which I had made my experiments, being bought at a common apothecary's, might, in fact, be nothing more than red precipitate; though, had I been anything of a practical chemist, I could not have entertained any such suspicion. However, mentioning this suspicion to Mr. Warltire, he furnished me with some that he had kept for a specimen of the preparation, and which, he told me, he could warrant to be genuine. This being treated in the same manner as the former, only by a longer continuance of heat, I extracted much more air from it than from the other.

This experiment might have satisfied any moderate sceptic; but, however, being at Paris in the October following, and knowing that there were several very eminent chemists in that place, I did not omit the opportunity, by means of my friend Mr. Magellan, to get an ounce of mercurius calcinatus prepared by Mr. Cadet, of the genuineness of which there could not possibly be any suspicion; and at the same time I frequently mentioned my surprise at the kind of air which I had got from this preparation to Mr. Lavoisier, Mr. Le Roy, and several other philosophers, who honored me with their notice in that city, and who, I dare say, cannot fail to recollect the circumstance.

At the same time, I had no suspicion that the air which I had got from the mercurius calcinatus was even wholesome, so far was I from knowing what it was that I had really found; taking it for granted that it was nothing more than such kind of air as I had brought nitrous air to be by the processes above mentioned; and in this air I have observed that a candle would burn sometimes quite naturally, and sometimes with a beautiful enlarged flame, and yet remain perfectly noxious

At the same time that I had got the air above mentioned from mercurius calcinatus and the red precipitate, I had got the same kind from *red lead*, or *minium*. In this process, that part of the minium on which the focus of the lens had fallen turned yellow. One-third of the air in this experiment was readily absorbed by water; but in the remainder a candle burned very strongly, and with a crackling noise.

That fixed air is contained in red lead, I had observed before; for I had expelled it by the heat of a candle, and had found it to be very pure. See vol. i. p. 192. I imagine it requires more heat than I then used to expel any of the other kind of air.

This experiment with *red lead* confirmed me more in my suspicion that the *mercurius calcinatus* must get the property of yielding this kind of air from the atmosphere, the process by which that preparation and this of red lead is made being similar. As I never make the least secret of anything that I observe, I mentioned this experiment also, as well as those with the mercurius calcinatus and the red precipitate, to all my philosophical acquaintance at Paris and elsewhere; having no idea, at that time, to what these remarkable facts would lead.

Presently after my return from abroad, I went to work upon the *mercurius calcinatus* which I had procured from Mr. Cadet, and, with a very moderate degree of heat, I got from about one-fourth of an ounce of it an ounce-measure of air, which I observed to be not readily imbibed, either by the substance itself from which it had been expelled (for I suffered them to continue a long time together before I transferred the air to any other place) or by water, in which I suffered this air to stand a considerable time before I made any experiment upon it.

In this air, as I had expected, a candle burned with a vivid flame; but what I observed new at this time (Nov. 19), and which surprised me no less than the fact I had discovered before, was that, whereas a few moments' agitation in water will deprive the modified nitrous air of its property of admitting a candle to burn in it, yet, after more than ten times as much agitation as would be sufficient to produce this alteration in the nitrous air, no sensible change was produced in this. A candle still burned in it with a strong flame, and it did not, in the least, diminish common air, which I have observed that nitrous air, in this state, in some measure does.

But I was much more surprised when, after two days, in which this air had continued in contact with water (by which it was diminished about one-twentieth of its bulk), I agitated it violently in water about five minutes, and found that a candle still burned in it as well as in common air. The same degree of agitation would have made phlogisticated nitrous air fit for respiration indeed, but it would certainly have extinguished a candle.

These facts fully convinced me that there must be a very material difference between the constitution of the air from mercurius calcinatus and that of phlogisticated nitrous air, notwithstanding their resemblance in some particulars. But though I did not doubt that the air from *mercurius calcinatus* was fit for respiration after being agitated in water, as every kind of air without exception on which I had tried the experiment had been, I still did not suspect that it was respirable in the first instance; so far was I from having any idea of this air being, what it really was, much superior in this respect to the air of the atmosphere.

In this ignorance of the real nature of this kind of air I continued from this time (November) to the first of March following, having, in the mean time, been intent on my experiments on the vitriolic acid air above recited, and the various modifications of air produced by spirits of nitre, an account of which will follow. But in the course of this month I not only ascertained the nature of this kind of air, though very gradually, but was led by it to the complete discovery of the constitution of the air we breathe.

Till this 1st of March, 1775, I had so little suspicion of the air from mercurius calcinatus, etc., being wholesome, that I had not even thought of applying to it the test of nitrous air; but thinking (as my reader must imagine I frequently must have done) on the candle burning in it after long agitation in water, it occurred to me at last to make the experiment, and putting one measure of nitrous air to two measures of this air, I found not only that it was diminished, but that it was diminished quite as much as common air, and that the redness of the mixture was likewise equal to that of a similar mixture of nitrous and common air.

After this I had no doubt but that the air from mercurius calcinatus was fit for respiration, and that it had all the other properties of genuine common air. But I did not take notice of what I might have observed if I had not been so fully possessed by the notion of there being no air better than common air, that the redness was really deeper, and the diminution something greater than common air would have admitted.

LABORATORY NOTES.

Limit of weighing; Condensation of Air on surface of Platinum; Gold covered Capsules; Weighing on Filters; Ready Method of showing Absorption of Hydrogen by Palladium.

BY J. LAWRENCE SMITH, OF LOUISVILLE, KENTUCKY.

The Limit of Weighing.

In quantitative analyses there is perhaps no one part in the process on which more time is needlessly lost than at the balance. While no chemist should consider any time lost which is needed for accuracy of results, yet we need not consume time attempting what is called accuracy of weighing far beyond the limit of error of the circumstances.

Under a balance in a laboratory, the containing vessels of platinum, glass, and porcelain (used to contain the materials weighed), are placed. Some of our most accurate and distinguished analytical chemists, as Rose and others, we are informed, only weighed within one milligramme, using one to two grammes of the material; in my own practice using from ·500 to 1 gramme, I consider it useless to weigh nearer than ½ milligramme. A little practice will soon enable any one to judge where to place the last ½ milligramme.

My remarks thus far apply to the great run of accurate chemical analyses. When it comes to the more precise study of atomic weights, I still adhere to the limit of ½ milligramme, but increase the amount of material experimented with.

In regard to assay analyses of gold and silver, of course these rules are not meant to apply, for there we have a special balance whose beam is no larger than a wire, and whose entire range is very small, and, therefore, can be kept to an adjustment far exceeding anything that can be done with analytical balances of the most approved make.

Condensation of Air on the Surface of Platinum.

In connection with the subject of weighing I would add the following observations of mine on platinum vessels.

After taking the weight of a clean platinum vessel, then wiping it thoroughly with a dry rag or soft paper and replacing it on the pan of the balance, it will be found to have lost weight; if of the ordinary size used in quantitative analysis, it will be found to have lost two milligrammes or more. If allowed to remain on the balance for fifteen or twenty minutes, it will be found to have recovered its weight. This change has usually been attributed to moisture, but I have clearly established that this is not the case. The following is the result of some accurate experiments :—

A new flat-bottom capsule, 4 centimetres in diameter and 2 centimetres deep, having about 50 centimetres square of surface inside and outside, was first thoroughly cleaned by boiling in a solution of caustic soda. After thorough washing in distilled water, it was heated to redness, allowed to cool, and in one hour weighed. It was now taken from the balance and wiped with clean filter paper, taking care to touch, as far as possible, all parts of the surface, without using any violent friction. After being submitted to this operation it was replaced on the balance, and it was ascertained to have lost 2 milligrammes, and after being allowed to remain for twenty minutes its original weight was restored.

The vessel was now transferred to a drying receiver over sulphuric acid, and allowed to remain six hours; placed on the balance, it weighed exactly what it did when placed in the drying receiver. It was now wiped as before, and on being replaced on the balance had lost 2 milligrammes, which it recovered, as before, in fifteen or twenty minutes.

The vessel was now transferred to a receiver in which the air was saturated with moisture from wet paper, placed on the glass support. After six hours the capsule was placed in the balance, when it was found to weigh just the same as it did when it was introduced into the moist atmosphere. A dry atmosphere or a moist atmosphere was then shown to have no effect in producing this temporary loss of weight in the capsule.

From these experiments it shows very clearly that there is air condensed on the surface of platinum that a little rubbing will remove; but it will soon return to the platinum after this treatment. The importance of this fact will be manifest to the analytical chemist, and make him cautious about taking the tare of his platinum vessels too soon after wiping them.

Gold lined Capsules and Crucibles.

While the analytical chemist cannot always indulge in every form of luxury of apparatus which might tend to facilitate and give precision to his researches, still they are very convenient and useful at times. Those who have had much to do with caustic potash and nitre heated to redness, know that silver vessels will not always answer their purpose. Under these circumstances gold vessels are very useful, but very expensive, and I have for some time been using what might be called a compromise vessel, made of platinum lined with gold; not platinum gilt, but made in the following manner: A thick sheet of platinum is taken and the requisite amount of gold melted on the surface, the whole is then rolled out to the proper thickness for capsules and crucibles, and these latter vessels then made out of this sheet. There was some little difficulty attending the making of the first vessels, but this was entirely overcome in the establishment of Johnson, Matthey & Co., Hatton Garden, London, where the vessels I use are made.

Weighing on Filters.

In weighing precipitates on the filter, the common method I employ is to take two filters of the size required, which have been cut to size together. These filters are placed on the balance and weighted one against the other. Ordinarily there will be but a few milligrammes difference in weight, which difference is marked in small numbers with pencil on the heavier. These filters are placed on the funnel side by side, the substance to be filtered is poured on one, and the filtrate from the first is poured on to the second filter, and so with the washings. When the filtration and washing are complete, the two filters are placed on the warm bath and dried; the weighing being conducted in the ordinary way, only the empty filter is placed on the balance as a tare to the other, and due allowance made for the excess of weight of one filter over the other in taking account of the weight of the substance. This has some advantages over the ordinary way with the filter, as there is no need of any special precaution of washing the filter prior to use in any way, or drying in a glass tube, and using any precaution against the hydroscopic moisture that is likely to be absorbed by the dry filter, for there is always a filter on each side of the scale subject to like conditions. It enables me at least to dispatch my work more readily and satisfactorily.

A Ready Method of showing the Absorption of Hydrogen by Palladium.

In the beautiful and important investigations of Graham upon the absorption of hydrogen by palladium, he described a very pretty method of making this absorption very apparent to the eye, viz., to take a strip of thin palladium, place wax or other non-conducting and pliable substance on one surface of the strip, and then attach it to the proper pole of a galvanic battery, and plunge it into water acidulated with sulphuric acid, when the hydrogen that is evolved at that pole, instead of escaping as gas, is absorbed by the palladium, which now bends and coils up on itself in virtue of the expansion on the exposed side.

This same result I have been in the habit of exhibiting in my laboratory, with a small piece of very thin palladium, about 1½ centimetres wide and 8 centimetres long. Light a small-sized Bunsen burner, hold the piece of palladium in the upper part of the flame; it will get red hot but remain in the same form as when introduced in the flame. Lower it now into the flame, until the unburnt gas from the centre of the flame strikes the bottom of the metal, when it will immediately coil upwards, and can be made to double on itself. Carry it back to the upper part of the flame and it will straighten itself again. There are some interesting chemical questions connected with this experiment that are worth working out, and at some leisure moment I will look into them; as, for instance, the absorption of the gas at this high temperature, and as to whether or not simply hydrogen is absorbed, the palladium thereby decomposing the hydrocarbon, etc.

ESTIMATION OF MANGANESE.

BY T. T. MORRELL.

In the course of analysis, manganese is generally separated as binoxide by bromine. If acetate of soda is first used to separate iron and alumina, a little of these will invariably be left in the solution, and go down with the manganese. The binoxide should be dissolved in hydrochloric acid, and, in the presence of chloride of ammonium, the traces of iron and alumina separated by ammonia, redissolving and precipitating two or three times if necessary. The solution is now ready to precipitate the manganese with ammonia and phosphate of soda.

In the absence of cobalt, time may be saved by again precipitating the manganese in the slightly ammoniacal solution by bromine, and directly igniting.

If the quantity is small (·10 or ·20 per cent. or less) we may proceed as follows: Saturate the filtrate from the ammonia precipitate with bromine and heat for a few minutes, add a drop or two of ammonia and again some bromine. The manganese falls at once as binoxide. Add, in a few minutes, a slight excess of ammonia, and boil gently until the fluid about the precipitate is colorless, and amounts to only from 10 to 20 c.c. Cool somewhat, and add a crystal of iodide of potassium weighing about 0·400 grm., and, when dissolved, six drops of colorless hydrochloric acid. The binoxide is at once dissolved, and yields an iodine solution which has always the same depth of color for the same amount of binoxide and the same dilution. The per cent. of

manganese is obtained by color in a Britton's colorimeter. After adding the hydrochloric acid, the color should be taken as soon as possible, as the solution of iodide with hydrochloric acid may develop a little color of itself in the course of fifteen or twenty minutes.

If the quantity of the original substance be as much as one gramme, as little as ·001 per cent. of manganese perceptibly tints the solution.

Severe test analyses, with a standard solution of chloride of manganese, gave results differing only ·003 per cent.

The method may be applied to some other estimations, but not to the assay of manganese ores, from the presence of peroxide of iron.

Cambria Iron Works, Johnstown, Pa.,
Oct. 2, 1874.

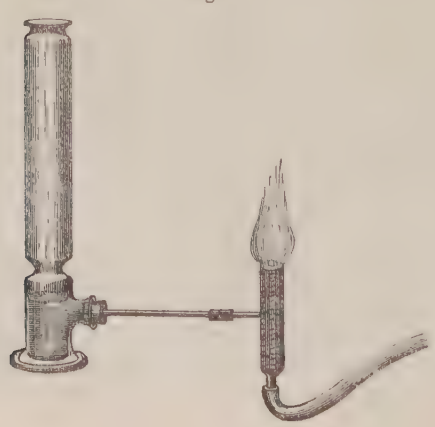
NEW EXPERIMENT FOR SHOWING THE GAS IN THE INTERIOR OF A FLAME.

BY EDWARD HART.

The value of an experiment is estimated by its power of commanding the student's attention, and the impression it makes upon his memory. The one which I propose is calculated to make such an impression, and, when properly performed, never fails to interest. The apparatus consists of a three-limb aspirator tube, having the lower part removed, and, when placed upside down, represented by Fig. 1. This is connected by means of the tube *a* with a small chloride of calcium jar. In the space between the inner and outer tube, *d c*, a circular argand wick is placed. The chloride of calcium jar is then filled with common kerosene oil to a point just above the level of the tube *a*, and to the tube *b* a piece of gum tubing is attached. By lighting the wick, and then sucking on the gum tube, the gas from the interior of the flame is drawn into the lungs. A piece of wide glass tubing is then placed in the mouth, and the gas expelled through it and lighted, producing a very large flame. If the oil be pure, the gas has no unpleasant taste, and is not injurious. The complete apparatus is shown in Fig. 2.

Fig. 1.

Fig. 2.



Lafayette College, Oct. 10, '74.

ON SOME NEW DERIVATIVES FROM ISOPURPURIC AND PYROGALLIC ACID.

BY ISIDOR WALZ, PH.D.

Preliminary Notice.

The experiments described below were made nearly two years ago, but having been unable since to find leisure for a careful quantitative examination of the substances obtained in their course, and foreseeing that this will be the case for some time to come, I beg to present in the following lines a preliminary notice of these new compounds:—

It is well known that by the action of potassium cyanide on picric acid in concentrated solutions, potassium isopurpurate is obtained. By drawing pyrogallic acid into the circle of the reaction (20 grammes potassium cyanide, 10 grammes picric acid, and 5 grammes pyrogallic acid, and each dissolved in the smallest possible quantity of water) a new salt is obtained, which resembles potassium isopurpurate, though it is less crystalline. Freed from the mother liquor by filtration and washing with cold water, it is a reddish-brown powder, moderately soluble in water, with an orange color. In this solution acids produce a purplish precipitate; salts of copper, calcium, barium, etc., give rise to purplish and buff-colored precipitates. Stannous chloride produces a bright crimson color. *The characteristic reaction for the new acid and salt is with ferrous sulphate, which produces a red coloration;* after a while oxidation takes place, and a dirty-green precipitate is produced. I have not been able to re-crystallize the potassium salt from its solution by the ordinary methods; the solution is decomposed when left to itself, or more rapidly on being boiled, and deposits a fine purple precipitate. This purple body is nearly insoluble in water and cold alcohol; in boiling alcohol it dissolves to some extent, with a pink color.

Addition of potassium ferricyanide to the solution of the potassium salt causes the precipitation of green flocks, which are partially dissolved, and, apparently, decomposed by washing with pure water, but soluble in alcohol, with a fine green color.

If the solution in which the purple body was formed is allowed to evaporate to dryness in the desiccator, over sulphuric acid, the vessel is found encrusted with a brown substance, which seems to be the result of still further decomposition of the original acid, while on the crusts, or intermixed with them, are noticed white octahedral crystals, of which a sufficient quantity was not obtained to test their behavior to reagents.

NOTES ON THE EARLY LITERATURE OF CHEMISTRY.

BY H. CARRINGTON BOLTON, PH.D.

V.

DEFINITIONS OF CHEMISTRY (AND ALCHEMY.)

"It is usual with writers to define the science of chemistry before they proceed to treat on it. It seldom happens, however, that descriptions of very complicated objects can possess that neatness and precision which are essential to a good definition."—Wm. Nicholson, 1795.

The widely varying ideas which have prevailed at different periods in the history of chemical science, with regard to its nature and object, are significantly portrayed in the definitions of chemistry which have obtained at these periods. It is believed that an examination of the following collection of definitions will be found instructive and interesting. Some of them, especially during the alchemical period, exhibit unmistakably the idiosyncrasy of their authors; this must be considered before comparison.

The definitions have been taken from original sources, except where indicated as quotations. A few of recent date have been added for comparison; these latter could be multiplied, but a complete collection has not been attempted, nor is it especially desirable.

Old Proverb. Alchimia est ars, cujus initium laborare, medium mentiri, finis mendicare.

Suidas. (A Greek lexicographer of the 10th century.) Chemistry, the preparation of silver and gold.

Paracelsus. 1537 (?). Chemistry is the art of resolving bodies. (Quoted by Boerhaave.)

Denis Lachaire. 1540 (?). Chemistry (alchemy) is that part of natural philosophy which teaches the preparation of metals on the earth, by imitating the operations of nature in the earth, as closely as possible. (Quoted by Pernety.)

Van Helmont. 1620 (?). Chemistry is the art of analyzing bodies by fire. (Quoted by Boerhaave.)

A Chymical Dictionary, London. 1650. Chimia is the art of separating pure from impure, and of making essences.

Salmon. 1672. Chemistry is an art, or a practical science which teaches the methods of resolving compound bodies into their natural principles, and by this means rendering them most pure and most efficacious as a medicine, either for curing diseases or for perfecting the imperfect metals. (Bibliothéque des Philosophes Chimiques, Paris, 1672.)

Lemery. 1675. Chemistry is the art which teaches the methods of separating the different substances contained in a componud. (Cours de Chymie, Paris, 1675.)

Boerhaave. 1724. Chemistry is an art whereby sensible bodies contained in vessels (or at least capable of being contained therein and rendered sensible) are so changed by means of certain instruments, and especially fire, that their several powers and virtues are thereby discovered with a view to the uses of medicine, natural philosophy, and other arts, and occasions of life. (Elementa Chemiæ, 1724.)

Grosses Vollstandiges Universal, Lexicon. 1742. Article "scheidekunst." The art and science of resolving all natural bodies into their elements.

Johnson's Dictionary, London. 1755. Quotes Boerhaave as above.

Pernety. 1758. Common chemistry (*chimie vulgaire*) is the art of destroying the compounds which nature has made. Hermetic chemistry is the art of assisting nature to perfect them. (Fables Egyptiennes et Grecques, Paris, 1758.)

Macquer. 1766. Chemistry is a science whose object is to discover the nature and properties of all bodies by their analysis and combinations. (Dictionnaire de Chymie, Paris, 1766.)

Gren. 1784. Chemistry teaches us the reciprocal actions of natural simple substances, the composition of bodies from them according to their proportions, and likewise the manner of separating or combining again to compound new bodies. (System Handbuch der ges. chemie, Halle, 1784.)

Pernety. 1787. Alchemy is a science and the art of making a fermenting powder which serves as a universal remedy for all the diseases of men, animals, and plants.

False alchemy cannot better be defined than the act of making one's self miserable, both as regards fortune and health. (Dictionnaire Mytho-hermétique, Paris, 1787.)

Fourcroy. 1789. Chemistry is a science which explains the intimate and reciprocal action of all bodies in nature on each other. (Leçons de Chimie, Paris, 1789.)

Chaptal. 1790. Chemistry is a science, the object of which is to ascertain the nature and properties of bodies. (Eléments de Chimie, Paris, 1790.)

Nicholson. 1795. Chemistry as a science teaches the methods of estimating and accounting for the changes produced in bodies by motions of their parts amongst each other which are too minute to affect the senses individually; and as an art it consists in the application of bodies to each other, in such situations as are best calculated to produce those changes. (Dictionary of Chemistry, London, 1795.)

H. Davy. 1802. Chemistry is that part of natural philosophy which relates to those intimate actions of bodies upon each other, by which their appearances are altered and their individuality destroyed. (Lectures, in Collected Works, vol. ii. 1839.)

Black. 1803. Chemistry is the science or study of those effects and qualities of matter which are discovered by mixing bodies variously together, or applying them to one another with a view to mixture, and by exposing them to different degrees of heat, alone, or in mixture with one another, in order to enlarge our knowledge of nature, and to promote the useful arts. (Lectures on Elements of Chemistry, Edinburgh, 1803.)

Thomson. 1810. The object of chemistry is to ascertain the ingredients of which bodies are composed; to examine the compounds formed by the combination of those ingredients; and to investigate the nature of the power which occasions these combinations. (System of Chemistry, 1810.)

Rees' Cyclopedia. 1819. Chemistry. A knowledge of those attractions which take place at insensible distances between the heterogeneous particles of matter.

Lassaigne. 1846. Chemistry is a science which has for its object the special knowledge of the mutual molecular action of bodies. (Abrégé Element de Chimie, Paris 1846.)

Otto. 1863. Chemistry is the science of the elements, and of the compounds which they are capable of forming. (Graham Otto's Lehrbuch der Chemie, Braunschweig, 1863.)

Frankland. 1866. Chemistry is the science which treats of the atomic composition of bodies and of those changes in matter which result from an alteration in the relative position of atoms. (Lecture Notes for Students, London, 1866.)

Bloxam. 1872. Chemistry describes the properties of the different particles of which all kinds of matter are composed, and teaches the laws which regulate their union with or separation from each other.

Rodwell. 1873. Chemistry is the science which treats of the various kinds of matter, whether simple or compound; their properties and the laws which govern their combination with, and separation from each other. (Birth of Chemistry, London, 1873.)

Roscoe. 1873. The science of chemistry has for its aim the experimental examination of the properties of the elements and their compounds; and the investigation of the laws which regulate their combination one with another.

Attfield. 1874. Chemistry is the study of the chemical force. The chemical force cannot be described, is only known by its effects . . . . resides in the atoms of elements, and is exerted only between definite weights and volumes.

Webster's Dictionary. 1874. Chemistry. That branch of science which treats of the composition of substances and the changes which they undergo.

School of Mines, Columbia College,
October, 1874.

ON THE MOLECULAR CONSTITUTION OF CHEMICAL COMPOUNDS.

BY GUY D. DALY, M.D.

A remarkable fact in recent chemical papers is the absence of the word "type" so prominent a few years ago, and a disposition to rely wholly on methods of decomposition and reactions to explain the molecular structure of compounds.

This answers very well for the simplest compounds, and the explanation given is generally correct; but, as we are as yet unacquainted with all the laws governing the union of the several parts of molecules, it is liable to be erroneous when the compound is complex or contains more than three elements. The "type" theory was defective, inasmuch as it did not trace the relations between structure and function, and even supposed it possible that a compound could be built on the type of a base, for example, and possess a neutral or acid function.

Another remarkable defect was that the simple substances chosen, to the type of which complex compounds were referred, often belonged to a different type, as, for example, acetic acid to the "water type," and this was the principal cause of the impossibility of tracing a definite relation between the structure and the function of molecules.

It will be found, however, that all substances of similar function are built on the same plan or type, and that there are no two compounds built on the same type that possess or perform different functions.

The apparent rigidity of this law disappears when we remember the wide range of properties that most elements possess, and although an element (as carbon) enters into the structure of bases, acids, ethers, etc., yet its relative position, in regard to the other atoms of the molecule and the function it performs, is different in each class, of "base," "acid," etc.

Compounds may belong to the same type and possess a similar function, although composed of wholly different elements; but it is necessary that there shall be some analogy between the *corresponding* element of each group. If we take formic acid as the standard

then if a given element, A, has some analogy with carbon, B, with oxygen, and D with hydrogen, then the compound

is possible, and D will be an acid. An example similar to this is found in sulphocyanic acid

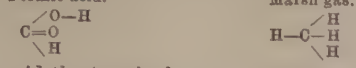
or its metameride

The common and necessary structure of all acids, therefore, is a central element analogous with carbon, and two atoms of oxygen or analogous elements arranged as above.

It will be observed, as an important effect of this law, that we can trace analogies which it would be otherwise impossible to do, and ultimately to find on what these common properties of different elements depend.

Besides the special function which each atom performs in a molecule, there is a general function performed by one part which is antagonistic but complementary to that performed by the other part, as may be represented by the following:—

Formic acid. Marsh gas.



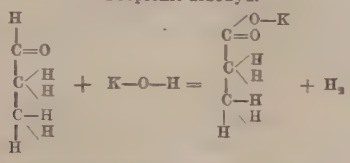
In the acid the terminal atom of hydrogen performing a general function different from that of the other atom and the rest of the molecule, and corresponding to that performed by

in marsh gas, a base; and, on the other hand, the terminal atom of hydrogen in marsh gas performing a general function corresponding to that of

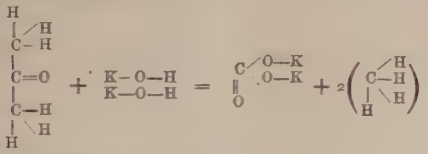
in formic acid.

The apparent inconsistency between this and the definite relations between structure and function which I previously insisted on, will be explained by the following reaction:—

Propionic aldehyd.

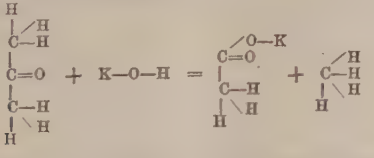


but the metameric ketone requires two equivalents of caustic potash to effect its decomposition, and the results are different:—



If, however, the terminal

in the ketone performed the *same* function as the terminal atom of hydrogen in the aldehyd, the following reaction would be possible:—



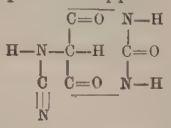
corresponding to the reaction of propionic aldehyd with one molecule of caustic potash.

As in the language of physics we say that light and heat, though not identical, are mutually convertible, so here it can be said that the function of the atom of hydrogen and the partial molecule

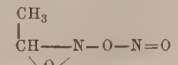
though not identical, yet one is analogous to or with the other.

The same may be said of ammonia, one atom of hydrogen performing a function different from that of the rest of the molecule. Kane's view is therefore correct, inasmuch as he represents it as the union of hydrogen and amidogen, and Hofmann's experiments are not conclusive in proving that all the atoms of hydrogen have the same function, as I will show further on. The following examples will bring prominently into view the ground taken in the first part of this paper.

Uric acid is at present supposed to have the form



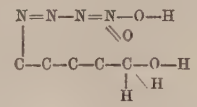
and nitrolic acid is thus represented:—



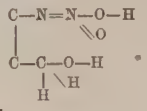
and dinitroethylic acid

and phosphorous acid

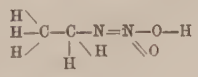
It will be immediately observed that there is no common structure given to these acids; that they are all different from one another, and the simplest organic acid, formic, about whose structure there is no doubt. But if we represent uric acid as



it makes it identical in structure with the higher terms of the diatomic acids (which are themselves produced by the union of two equivalents of formic acid). There are, of course, several other ways in which the above elements may be represented without destroying the "acid" type—some possible metamerides—but there is no doubt that its general plan of structure is as above represented. And nitrolic acid

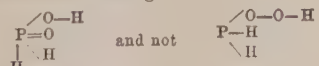


and dinitroethylic acid



and phosphorous acid

hypophosphorous acid being



and phosphoric acid

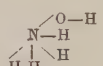
In all a common relation of structure, not only with one another but with formic or nitric

or any other simple acid, is immediately perceived.

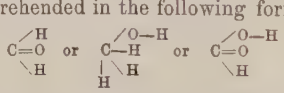
It must be remembered that I only insist on the general plan of structure as given above, careful reactions being relied on to determine the exact position of each individual atom in the molecule.

As nitrogen has nearly as wide a range of properties as carbon, that is, forming a base, acid, aldehyd, etc., it must not be supposed that a compound, as acetamide, for example, is built on the type of ammonia, because it contains nitrogen, and for the same reason that propionic aldehyd does not belong to the type of marsh gas, a base, Acetamide is truly an aldehyd.

And compounds said to be built on the type of hydrated oxide of ammonium



are not bases but alcohols. Their general resemblance to methyl alcohol is evident at a glance, in which nitrogen occupies the position and performs the function of carbon in the monobasic alcohols. And in regard to the so-called organic bases which contain oxygen, it will be found that they are polybasic aldehyds; they certainly do not belong to the type of bases in which are included the hydrocarbons, methyl, aniline, etc.; the only relative position which oxygen can occupy in molecules is comprehended in the following forms:—



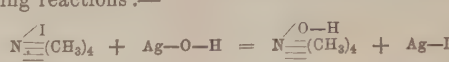
and they are the aldehyds, alcohols, and acids (the ethers, ketones, etc., being merely varieties of the above types), for although carbon may sometimes perform the function of oxygen, as in sulphocyanic acid

and other types, there is no example among any of the simple compounds, at any rate, where oxygen can perform a function corresponding to that of carbon in marsh gas or methyl alcohol, etc., or of nitrogen in ammonia or nitric acid. Sulphur is intermediate in that respect, as in sulphuric acid

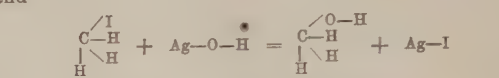
it performs a function analogous to that of carbon in formic or carbonic acids, and in

it performs a function similar to that of carbon in marsh gas or any base, and, as we have already seen in sulphocyanic acid, its position and function corresponds to that of oxygen in the oxy-acids, and it has other analogies with oxygen; but what I might call the range in type-forming power of the latter is very limited. There is, therefore, I think, good reason to class and represent the so-called bases that contain oxygen with aldehyds; and, indeed, the results of reactions are far more in accordance with this view than with any other.

That the hydrated oxide of ammonium compounds belong to the "alcohol" type, may be seen from the following reactions:—



and



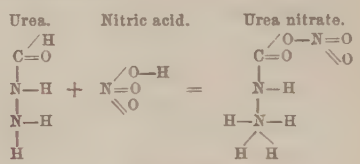
strictly analogous compounds suffering the same change, and giving rise to results that belong to the same type.

The compound

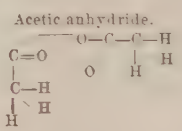
must also be classed in the same type.

The union of acids with these aldehyds corresponds to the anhydrides:—

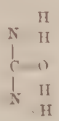
Urea. Nitric acid. Urea nitrate.



Acetic anhydride.



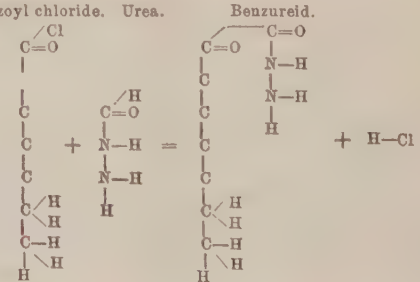
Urea may, however, be



in which case it would correspond with the ketones.

Another reaction which shows the type of urea is the following:—

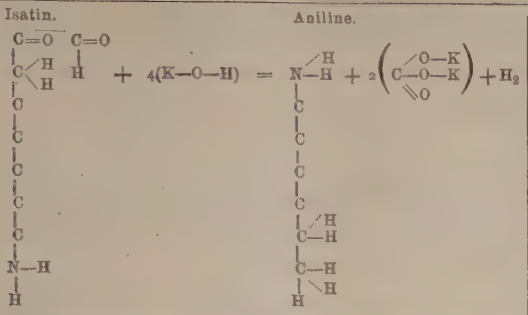
Benzoyl chloride. Urea. Benzureid.



The union of two aldehyds producing a diatomic compound, as oxalic acid, is formed by the union of two equivalents of formic acid.

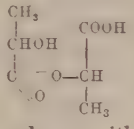
The number of atoms of oxygen in these aldehyds is an indication of their atomicity:—

Isatin. Aniline.

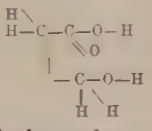


Without saying that the above represents properly the disposition of each atom in the molecule of isatin, there can be no doubt that its general structure is as above given, and it represents the decomposition with caustic potash in a very intelligible manner. When cinchonia is distilled, it yields quinoline, and the decomposition is similar to that given for isatin; it is a monatomic aldehyd; quinia ($C_{20}H_{24}N_2O_2$) reacts analogously, and is a diatomic aldehyd; the same may be said of strychnia.

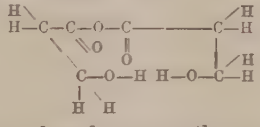
The form of lactic anhydride as at present given is faulty:—



as it is not in accordance with the anhydride type. Lactic acid is—

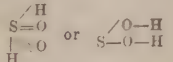


and lactic anhydride, by analogy—



The difference, though apparently very slight, is of importance, as the latter assimilates it to the ordinary anhydrides.

Hydrosulphurous acid SO_2H_2, as at present represented, is incorrect—



but if we represent it—

the form is identical with that of formic and all other acids.

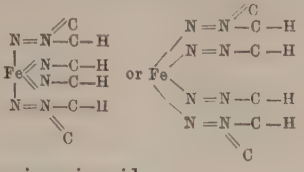
In attempting to give the structure of hydroferrocyanic acid, the following facts aid us:—

(1.) That the iron is not a basyl.

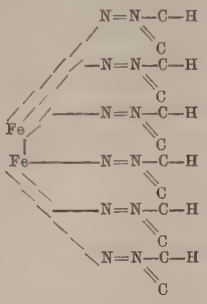
(2.) That the acid is tetrabasic.

(3.) That carbon sometimes performs the function of oxygen in acids.

Hence, the following is its form:—

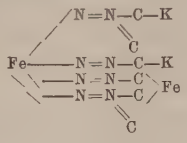


and hydroferricyanic acid—

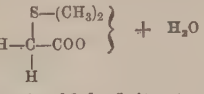


in which iron acts as in $FeCl_3$ or Fe_2Cl_6.

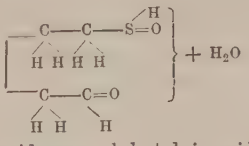
In ferrocyanide of potassium and iron, each atom of iron performs a different function—



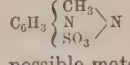
The so-called base methylthetine has recently been thus represented:—



but as it is a diatomic aldehyd, its structure is probably the following:—



Diazo-orthoamidoparasulphotoluic acid has been thus represented:—

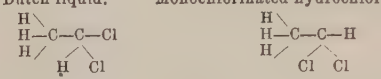


There are several possible metamerides, but its general form is—

or a nitrogen or carbon atom may occupy the relative position of sulphur, or the acid may be diatomic; but its structure must correspond with that of acids generally.

To return to the functions of the hydrogen atoms in ammonia. It is well known that the substitution (of chlorine) compounds derived from hydrochloric ether are not affected when boiled with an alcoholic solution of potash, whereas the metameric compounds derived from Dutch liquid are decomposed, and the fact can only be explained by supposing that an atom of hydrogen performs the function that an atom of chlorine does in the latter, and I represent them in this manner in order not to overlook the fact.

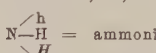
Dutch liquid. Monochlorinated hydrochloric ether.



in the former, with K—O—H, the terminal atom of chlorine is removed, and forms chloride of potassium; but, in the latter, hydrogen forming no compound with potassium, the ether is not decomposed. This reaction is important in connection with Hofmann's experiments.

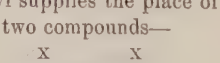
I take the following from Miller's Chemistry:—

"Let the three atoms of hydrogen in ammonia be represented by the letters h, H, and *H*; and let



Suppose that a substitution base were formed, in which the atom of hydrogen, h, were displaced by a radicle called X, forming a new base—

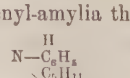
the other atoms of hydrogen, H and *H*, admit of being displaced by other radicles Y and Z. Suppose that X represents phenyl (C_6H_5), Y amyl, and Z ethyl; the question is, whether the same compound will be formed indifferently when amyl is substituted for H, and ethyl for *H*, or when ethyl supplies the place of H, and amyl of *H*—whether the two compounds—



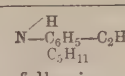
will be identical.

Hofmann compared phenyl-amyl-ethylia ($C_{13}H_{21}N$), prepared by acting on phenyl-amylia $\left.\begin{matrix}C_6H_5\\C_5H_{11}\\H\end{matrix}\right\}N$ by ethyl bromide C_2H_5—Br, which would yield $\left.\begin{matrix}C_6H_5\\C_5H_{11}\\C_2H_5\end{matrix}\right\}N$, with the compound phenyl-ethyl-amylia, which is $\left.\begin{matrix}C_6H_5\\C_2H_5\\C_5H_{11}\end{matrix}\right\}N$, formed by decomposing $\left.\begin{matrix}C_6H_5\\C_2H_5\\H\end{matrix}\right\}N$ with amyl bromide.

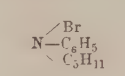
I will represent phenyl-amylia thus:—



Now, keeping in view the action of caustic potash on Dutch liquid, and its non-action on the hydrochloric ether, ethyl bromide would thus act on phenyl-amylia—



for otherwise the following compound would be formed:—

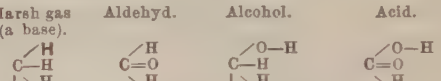


The supposition, therefore, that the three atoms of hydrogen in ammonia perform the same function is incorrect, and Kane's old theory is revived—the union of hydrogen and amidogen—

the heavily marked H indicating the difference between it and the others.

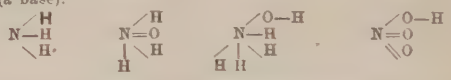
To return to the simple compounds. We find that carbon in the following compounds does not occupy the same relative position and perform the same function in any two instances:—

Marsh gas (a base). Aldehyd. Alcohol. Acid.

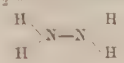


Now if we add the molecule CH_2 to any one of them, the general function of the second atom of carbon is the same as the first. Similarly the same can be said of nitrogen in the following:—

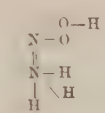
Ammonia (a base). Aldehyd. Alcohol. Acid.



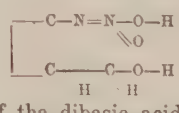
Hence, we say that nitrogen is analogous with carbon in many respects, and has a wide range of properties. Now, we can add a molecule to any of the above, corresponding to CH_2 in the carbon compounds, as—



or to the acid



I do not say that these compounds are actually possible, but merely use them to illustrate the theory. Now, these facts being admitted, the representation of nitrolic acid, for example, in the following manner, is simple, and consistent with the theory:—

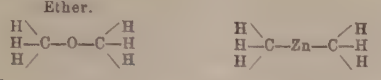


and of the type of the dibasic acids, the carbon and nitrogen atoms performing the same general function, and corresponding to CH_2 in acetic acid, or any higher term of the monobasic acids which contain no nitrogen. Sulphur, for example, also forms nearly as many types as carbon, and is analogous to it. Silicon also.

We should attempt to see how far these analogies extend. Zinc forms a compound analogous to ether,

and performs the function therein that oxygen does in the latter compound:—

Ether.



Now the question is, can zinc perform the function that oxygen does in the acids; or, in other words, is the following compound possible:—

and is the following compound possible:—

We know that carbon can replace oxygen, as in sulphocyanic acid—

and we might naturally suppose the above acid is capable of being formed. But it is only by exhausting the analogies, as it were, that we can find *all* the properties of any element.

ON THE

DETECTION OF THE COMPOUNDS OF PHOSPHORIC AND OXALIC ACIDS WITH CALCIUM, MAGNESIUM, BARIUM, STRONTIUM, AND IRON, IN THE AMMONIUM SULPHIDE OR AMMONIUM HYDRATE PRECIPITATE, IN QUALITATIVE ANALYSIS.

BY DR. A. HILGER.

Translated by Charles McIntire, Jr.

The detection of these known compounds in the ammonium sulphide or ammonium hydrate precipitate of acid solutions, remains for the little practised experimenter, with the generally followed methods, always a complicated, frequently a difficult task; it is possible to precipitate the phosphoric acid by means of tin and nitric acid, or in an acetic acid solution in the presence of iron by boiling, or even in other ways.

Much observation and experience in my laboratory course brought me to a much simpler and shorter method, which, from its correct results and quick execution, might be worthy of communication here. I give below the essential points in the method without explanation as to the complete separation of the whole precipitate formed by ammonium sulphide, or ammonium hydrate.

Having the ammonium sulphide precipitate, the ammonium hydrate precipitate requiring no looking into, the following is the method of procedure employed.

The hydrochloric acid, or in presence of cobalt or nickel, the aqua regia solution will be completely freed from the separated sulphydric acid by heating; then at once, before further separation, test in two separate portions:—

1. For phosphoric acid with ammonium molybdate, regarding the known precautions. Should silicic acid be suspected to be present in the ammonium sulphide precipitate, the hydrochloric solution must first be evaporated to dryness, and the residue again taken up by acid.

2. For oxalic acid, by the addition of sodium acetate in excess, indeed preferably in a solid form.

Both tests are very good to show the proper course.

The remainder of the acid solution of the ammonium sulphide precipitate is mixed with an excess of an alkali, and the resulting precipitate is, after washing, dissolved in hydrochloric acid; at the same time, the alkaline solution is tested after the known methods for zinc, chromium, aluminium, etc.

The acid solution of the alkali formed precipitate is mixed with ammonium chloride and ammonium hydrate in excess, by which there can be precipitated, as is known—

Barium
Calcium
Magnesium
Strontium
Iron
} combined with phosphoric acid.

Calcium oxalate, sesquioxide of iron, calcium fluoride, the rarer earths as well as manganese and chromium, uranium, while the solution contains cobalt, nickel, manganous oxide, etc. These are treated after the known methods.

The precipitate must be treated with ammonium carbonate if uranium or the rarer earths are to be taken into consideration. Then dissolve the residue in hydrochloric acid, the presence of phosphates, oxalates, as well as of iron, is determined very quickly in the following way:—

1. A small portion of the solution is tested for iron with potassium ferrocyanide, or potassium sulphocyanide.

2. A second portion is mixed with dilute sulphuric acid, or an alkaline sulphate, and allowed to stand for some time. Barium and strontium will be precipitated as sulphates. Should there be a precipitate, they can be separated according to the known methods. Treatment of the precipitate with ammonium carbonate in the warm to change the strontium sulphate to strontium carbonate can be usually employed.

3. The third and by far the largest portion is used for the detection of the phosphates of iron, calcium magnesium, and of calcium oxalates. To this end add in the first place crystallized sodium acetate in excess, to effect the separation of calcium oxalate and iron phosphate after short standing. In all cases the resulting precipitate is ignited on platinum foil, and, after cooling the mass, dashed over with hydrochloric acid; an effervescence shows certainly the previous presence of calcium oxalate; the resulting hydrochloric acid solution shows, by means of potassium ferrocyanide, the presence of ferric phosphate. The filtrate from this precipitate (calcium oxalate and ferric phosphate) is then treated with an excess of ammonium oxalate, for the precipitation of every calcium compound combined with phosphoric acid. The filtrate from this, which contains magnesium phosphate and iron not combined with phosphoric acid, is mixed with an excess of ammonium hydrate, after a previous addition of an excess of tartaric acid. The magnesium is precipitated as magnesium phosphate free from iron; the iron being held in solution by the copious addition of tartaric acid.

This communication offers, to my mind, in a much shortened method a general advantage that one will be put on the right track at the commencement of the separation of the ammonium sulphide precipitate, as to the presence of phosphates and oxalates; besides a complete separation of the phosphoric acid from the solution is not necessary.

It is easily seen that the same method can be employed in the research of the ammonium hydrate precipitate, which can be obtained before the ammonium sulphide precipitate.

Erlangen, February, 1874.

Remarks on the above Method by Dr. R. Fresenius.—In the employment of the recommended method one will be thrust on a difficulty in complicated cases caused by the well-known mutual retention of a metallic sulphide, hydrate, or salt, which may be contained in the precipitate formed by ammonium sulphide, concerning which, I think, it is necessary to give a caution:—

1. By the addition of potassium hydrate in excess to the hydrochloric acid solution the precipitate becomes, when oxide of chromium is present along with the zinc oxide, a zinc oxide, chromium oxide precipitate, so that possibly both metals are not found, but in every case only a part is found in the alkaline solution.

2. By a solution of the phosphate of the alkaline earths and iron oxide in hydrochloric acid, and the addition of potassium hydrate, the phosphoric acid is precipitated chiefly as basic ferric phosphate; if the precipitate is again dissolved in hydrochloric acid and reprecipitated by the addition of ammonium chloride with ammonium hydrate, basic ferric phosphate is again precipitated, but frequently no calcium, strontium, barium, and no magnesium. It is necessary in this case to look for the alkaline earths in the filtrate containing cobalt and nickel.

3. By heating the hydrochloric acid solution of the precipitate obtained by an excess of potassium hydrate with sodium acetate, a separation of ferric phosphate does not always take place; contrarywise, if the iron exists considerably in excess over the phosphoric acid, then it happens that a red solution of ferric acetate is formed in which it is well known ferric phosphate is soluble. By the presence of an excess of phosphoric acid a corresponding amount of ferric oxide is thrown down, whereby all the phosphoric acid is combined with the ferric oxide.—*Fresenius, Zeitschrift*, xiii. 132.

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS.

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H. C. Humphrey,
C. A. Joy, Ph.D.,
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J. M. Merrick, B.Sc.,
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Ira Remsen, Ph.D.,
C. A. Schaeffer, Ph.D.,
P. Schweitzer, Ph.D.
W. Shapleigh,
T. O'C. Sloane, E.M.,
Prof. A. P. S. Stuart,
D. K. Tuttle, Ph.D.,
E. Waller, E.M.,
E. H. Williams, A.B.

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On **coniferin** and its transformation into the aromatic principle of *vanilla*.—F. Tiemann and W. Haarmann.—Coniferin was obtained from *Abies excelsa* and *pectinata*, from *Pinus strobus* and *Cembra*, from *Larix europea*, etc. From analyses and decompositions the formula appears to be $C_{16}H_{22}O_8 + 2Aq$. Treated with emulsin it is decomposed as follows: $C_{16}H_{22}O_8 + H_2O = C_6H_{12}O_6 + C_{10}H_{12}O_3$. Grape-sugar and the product $C_{10}H_{12}O_3$ are thus the only products. When the substance $C_{10}H_{12}O_3$ is treated with sulphuric acid and potassic bichromate, a crystallizing product is obtained, which possesses markedly the taste and odor of vanilla. This has the formula $C_8H_8O_3$, and has acid properties. A number of salts were prepared and analyzed. Their general formula is $C_8H_7RO_3$. Bromine and iodine substitution-products were also prepared, and their analyses verified the above formulas. The substance $C_8H_8O_3$ is in every respect identical with the active principle of the vanilla-pod, viz., vanillin, as was proved by a careful comparison of the properties of the two substances. Treated with fusing potassic hydroxide, coniferin and vanillin yield protocatechuic acid. By dry distillation they yield pyrocatechin. Treated with dilute chlorhydric acid in sealed tubes at a high temperature, vanillin yields protocatechuic aldehyde. The formula which is derived from these reactions is $C_6H_3\begin{cases}OCH_3\\OH\\COH.\end{cases}$ The formula of the product above mentioned, as obtained directly from coniferin, is

$$C_6H_3\begin{cases}OCH_3\\OC_2H_5\\COH\end{cases} = C_{10}H_{12}O_3.$$

(*Note.*—If vanillin is an aldehyde, why was its conversion into the corresponding acid not effected? One of the strongest proofs of its aldehyde nature is lacking.—I. R.)

On **mercury-amides**.—A. Oppenheim and S. Pfaff.—When acetanilide and mercuric oxide are fused together, a substance $(C_2H_3ONC_6H_5)_2Hg$ is obtained. When the acetamide compound $Hg(NHC_2H_3O)_2$ is treated with iodine, carbon bisulphide, or sulphocarbanilide, acetanilide is reproduced in large quantity.

Contributions to the knowledge of **terpenes**.—A. Oppenheim and S. Pfaff.—Four terpenes, viz., terebene, borneene, geraniene, and eucalyptene, were examined. By treatment with iodine they all gave paramethylpropylbenzene. American oil of turpentine and oil of citron give the same hydrocarbon. It is a suspicious circumstance that all terpenes yield *paracymoles*. It may be that the action of iodine is sufficient to cause a molecular rearrangement, and thus to prevent the recognition of the original structure of the terpenes.

On the compounds related to Stenhouse's substance. **Urethan-derivatives**.—C. Bischoff.—Stenhouse's substance, obtained by the action of chlorine on cyanhydric acid in alcoholic solution, has been represented by the author by the following formula:—

$$CHCl_2—CH\begin{cases}HN—CO—C_2H_5O\\HN—CO—C_2H_5O.\end{cases}$$

By the action of acetal on urethan, ethylidene-urethan is produced—

$$CH_3—CH\begin{cases}HN—CO—C_2H_5O\\HN—CO—C_2H_5O.\end{cases}$$

If, instead of acetal, monochloracetal is employed, the product is—

$$CH_2Cl—CH\begin{cases}HN—CO—C_2H_5O\\HN—CO—C_2H_5O,\end{cases}$$

which is identical with the monochlorinated body prepared by Stenhouse. Chloral and urethan give—

$$CCl_3—CH\begin{matrix}OH\\ HN—CO—C_2H_5O.\end{matrix}$$

Bromal gives a corresponding bromine derivative. Crotonchloral and urethan give—

$$C_4H_5Cl_3\begin{matrix}OH\\ HN—CO—C_2H_5O.\end{matrix}$$

Aldehydes combine with urethan, water being separated and bodies similar to those mentioned being formed. Valeric aldehyde, monochlorvaleral, and oil of bitter almonds were employed.

On **oxethenetoluidin.**—Eugen Demole.—This body was prepared by allowing ethylene oxide to act upon paratoluidin. Its formula is $C_9H_{13}NO$. A number of its salts were prepared. Methyl iodide yields with it products in which amide-hydrogen atoms are replaced by CH_3. The constitution of oxethenetoluidin is—

$$\begin{matrix}CH_2.OH\\ |\\ CH_2.NHC_7H_7.\end{matrix}$$

New method for the quick preparation of **glycol.**—E. Demole.

Communications from the laboratory at Greifswald. —H. Limpricht.

On a new nitrotoluidin.—Liquid dinitrotoluene from liquid orthonitrotoluene was converted into nitrotoluidin, and this, by heating with chlorbenzoyl, converted into the benzoyl compound, which, by repeated recrystallizations, was rendered almost pure. When this benzoyl-compound is heated with potassic hydroxide or dilute chlorhydric acid, the new nitrotoluidin is obtained.

Concerning the **ammonia soda-process.**—R. Günsberg.—Author is of the opinion that this process can be employed to the greatest advantage when the proportions of sodic chloride, ammonia, and water are so regulated as to yield a saturated solution of sal-ammoniac after the decomposition is completed. As a result of calculations the following proportions are found to be favorable: 58·5 parts NaCl, dissolved in 180 parts of ammoniacal liquid, in which 10·96 per cent. ammonia is contained, and this solution then treated with CO_2. In 100 parts of the solution thus obtained there were found to be contained 5·742 parts of soda.

On the constitution of **hyposulphurous acid.**—H. Bunte.—The principal question here is with reference to a choice between the formulas $SO_2\begin{matrix}SH\\ OH\end{matrix}$ and $S_2O\begin{matrix}OH\\ OH.\end{matrix}$ If the former is correct, then it is to be expected that the H of the SH group will be replaced by ethyl by treatment with ethyl bromide. This is found to be the case. If an acidified solution of sodic ethylhyposulphite is boiled for some time, sulphuric acid and mercaptan are obtained. There would seem to be no doubt then in regard to the connection between sulphuric and hyposulphurous acids indicated by the following formulas:—

$$SO_2\begin{matrix}OH\\ OH\end{matrix} \qquad SO_2\begin{matrix}SH\\ OH.\end{matrix}$$

On the constitution of **terebic acid.**—R. Fittig and B. Mielck.—Pyroterebic acid was found to have the formula—

$$\begin{matrix}CH_3\\ CH_3\end{matrix}\!\!>\!CH—CH=CH—CO—OH.$$

The caprionic acid produced from this by the action of hydriodic acid is identical with the acid obtained from the cyanide of the amyl alcohol of fermentation. Terebic acid is undoubtedly the lactid-anhydride acid. The formula of the latter acid is probably

$$\begin{matrix}CH_3\\ CH_3\end{matrix}\!\!>\!CH—\underset{\underset{OH}{|}}{CH}—\underset{\underset{CO—OH.}{|}}{CH}—CO—OH$$

It is hence a triatomic, bibasic acid, homologous with malic acid, oxypimelic acid. When this is set free from its salts, it is decomposed into water and a lactide:—

$$\begin{matrix}CH_3\\ CH_3\end{matrix}\!\!>\!CH—\underset{\underset{O—}{|}}{CH}—\underset{\underset{CO.}{|}}{CH}—CO—OH$$

This is terebic acid.

On **gentianin.**—H. Hlasiwetz and J. Habermann.—Gentianin is very nearly related to maclurin. Treated with KOH, it yields an acid isomeric with protocatechuic acid, phloroglucin, and acetic acid. I. R.

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On the preparation of **glycol.**—E. Demole.—By heating dry potassic acetate, ethylene bromide, and alcohol (sp. gr. ·83) for some time together, there is formed glycol, which is separated by distillation. This method is far superior to the ordinary one, both as to economy of time and material. The reaction takes place by the formation of bromacetin, which latter is decomposed, by boiling with 80 per cent. alcohol in presence of ethylene bromide, into glycol and acetic ether. This reaction does not take place without the presence of ethylene bromide, and for this reason half the bromide used does not take part in the reaction, but is recovered. The proportions are, one molecule ethylene bromide, two molecules potassic acetate, with twice the weight of the latter of 80 per cent. alcohol.

On **aromatic hydroxethylenamines.**—E. Demole. —The author has combined ethylene oxide with anilin and toluidin, and describes the aromatic products and derivatives. Oxethenanilin is prepared by bringing equal molecules of C_2H_4O and $C_6H_5NH_2$ in a pear-shaped vessel, and hermetically closing the opening. At 50° the reaction is finished in a few hours. On distillation anilin first passes over, then the thermometer rises at intervals until it finally reaches 360°; above that the distillation was continued, furnishing a non-crystallizable thick liquid. The oxethenanilin boils at about 280°, sp. gr. 1·110 at 0°, and is separated from the distillate by fractional distillation. It is slightly soluble in water, but readily so in alcohol, ether, and chloroform. It combines with acids, forming salts generally soluble in water. Its platinum salt—

$$2(C_2H_4OC_6H_7NHCl)PtCl_4,$$

gives fine reddish-brown crystals. The compound with toluidin is prepared in a similar manner, crystallizes, boils at 286°–288°, and is similar to the above in properties.

On new **silicium compounds.** — A. Ladenburg. — Zinc ethyl acts upon silico-methyl ether as follows:—

$$Si(OCH_3)_4 + Zn(C_2H_5)_2 = SiC_2H_5(CH_3O)_3 + ZnOCH_3C_2H_5.$$

The product is named orthosilicopropionic methyl ether.

Orthosilicoacetic ether, $SiCH_3(OC_2H_5)_3$, is obtained by heating under pressure, at the temperature of 300°, a mixture of silicic ether and zinc methyl. By the action of HI, it is decomposed, forming silicoacetic acid, a dry white powder. It is thought that it is partly converted into the anhydride at 100°. The author has succeeded in forming compounds of silicon with aromatic radicals. This can be accomplished by the following reaction:—

$$SiCl_4 + H_6(C_6H_5)_2 = SiCl_3C_6H_5 + HgC_6H_5Cl,$$

silicophenyl chloride being formed. The author's studies also include phenylsilicic acid $SiC_6H_5O_2H$, silicophenyl tr ethyl, and tolyl compounds.

On the reactions by the incomplete **combustion of illuminating gas** and the conduct of the same when heated with exclusion of air.—R. Blochmann.—Among many other results the author confirmed the observation that during such combustion acetylene is formed. Gas freed from aqueous vapor and CO_2 was passed through a porcelain tube heated to nearly 1000° C., and analyzed.

	Composition of gas before passing through tube.		
H	49·57	61·96	
CH_4	36·92	30·49	
CO	5·63	5·26	
C_2H_4	3·92	1·26	1·43
C_4H_8	2·99	0·17	
N	0·97	0·86	
	100·00	100·00	
C_2H_2	0·06	0·11	direct est.

The interior of the tube was found coated with carbon.

On **dimethyl isobutyl carbinol** and the heptylen therefrom.—D. Pawlow.—This new alcohol is formed by the action of valeryl chloride on zinc methyl. Methyl isobutyl acetone is formed, which combines slowly with sodic bisulphite, and the alcohol is obtained from this compound. It becomes thick at 20°. According to its formation it should be—

$$C(OH)(CH_3)(CH_2(CH_3)_2)(CH_3)$$

and its properties agree with this formula. The iodide of the carbinol decomposed with alcoholic potassa furnishes a new heptylene—

$$C(CH_3)(CH_3)(CH{=}CH(CH_3)_2) \quad \text{or} \quad C(CH_3)(CH_3)(CH_2CH(CH_3)_2).$$

On **paramidometasulphotoluic acid.**—Dr. H. von Peckmann.—This acid is obtained by heating paratoluidin with sulphuric acid to 180°. It crystallizes from hot water in sulphur-yellow needles but on precipitation from its salts is colorless. Its most important salts and derivatives are described. Formula of crystals—

$$C_6H_3(CH_3)(SO_2OH,H_2O)(NH_2).$$

Contributions to a better knowledge of the **starch group.**—Walter Naegeli.—This article embraces the principal points of a more lengthy publication. In brief, starch consists of several mutually convertible substances which can be distinguished by difference in solubility and coloration with iodine. By treating starch meal with acids in the cold, there remains a substance soluble in warm water which can be crystallized. It is colored violet by iodine, or red if the latter be in excess. It is named amylodextrin. On analysis it gave C 43·61, H 6·68, corresponding to $C_{36}H_{62}O_{31}$, ash deducted It turns the plane of polarization to the right, and in this regard stands between starch and dextrin. The starch group consists of modifications which when treated with iodine are colored from red, through violet and blue, then the amylodextrin, which consists of violet and red modifications, and through the red dextrin to yellow.

Investigations on the source of the **acids of the stomach.**—Richard Maly.—Irritation of the inner membrane of the stomach neutralizes the acidity and lessens the amount of acid in the urine. Lactic acid in dilute solution partially decomposes chlorides which may be found in the stomach, liberating hydrochloric acid. But in the normal gastric juice (of dogs) no lactic acid is found. Hence, in the formation of the free hydrochloric acid, lactic acid takes no part.

Contribution to the knowledge of **chloral.**—O. Wallack.—Chloral and anilin act upon each other violently, forming a new compound corresponding to Schiff's ethylidendiphenamin. The reaction takes place as follows:—

$$CCl_3COH + 2C_6H_5NH_2 = H_2O + CCl_3CH(NHC_6H_5)(NHC_6H_5),$$

and the substance is crystallized from alcohol or a mixture of alcohol and ether.

With toluidin a similar body is formed. By the action of chloral, toluidin, and alcohol, is obtained—

$$CCl_3CH(OC_2H_5)(OH) + C_6H_4CH_3NH_2 = CCl_3CH(OC_2H_5)(NH.C_6H_4CH_3) + H_2O$$

Xylidin and chloral form a compound corresponding to that from anilin. Acid amides combine with chloral by direct addition.

The salts of aromatic amides act upon chloral as upon aldehyds, in the same manner as the free bases themselves.

Nitric acid, as is known, converts it into trichloracetic acid. The author finds that by passing gaseous nitrous acid into anhydrous chloral it turns deep green, but no reaction takes place. But on heating in a closed tube it becomes yellow, and on opening the tube gas is given off under great pressure and trichloracetic acid is found. Chloropicrin is also formed.

On the action of **potassic cyanide on chloraldehyds.**—O. Wallack.—Chloral dissolved in alcohol and added to commercial potassic cyanide gives off cyanic acid mixed with some carbonic acid, and there is formed very readily dichloraceticethyl ether and chloralcyanhydrate.

$$CCl_3COH + KCN + C_2H_5OH = KCl + HCN + CCl_2H,COOC_2H_5.$$

On **metachlorphenol** and its nitro-derivatives.—A. Faust and H. Müller.—Colorless phenol was treated with chlorine gas, and distilled; the portion going over at 180°–200° was submitted to fractional distillation, and there was obtained a new monochlorphenol boiling at 175·5 to 177°. This same body was obtained by Schmitt by distilling the platinum salt of diazophenol hydrochlorate. Numerous nitro-derivatives are described.

Correction of earlier statements about **chlornitrophenol.** — A. Faust. — "Parachlormetanitrophenolbarium" crystallizes with four molecules of water instead of two.

"Metanitrodichlorphenolkalium," crystallizes with one molecule of water.

The following do not exist.

Chlordinitrophenol fusing at 103°, also the compound so named by Peterson fusing at 69°, and another by Peterson and Bähr-Predari fusing at 106°. The existence of one by the same fusing at 114° is doubtful.

On **isonolylamide** and **isononylic acid.**—H. A. Kullhem.—Iso-octyle iodide was treated with potassic cyanide in alcohol, forming the cyanide or nitrile. This was boiled for some ten hours with alcoholic potassa, but, instead of forming the acid as expected, was converted into isononyl amide. A small quantity of an acid was formed. By continuing the boiling for thirty hours the potassic solution was found to contain isononylic acid, boiling at 244–246° at 760 mm.

On **metachlorphenol** and the monosulpho-acids to be obtained from it.—J. G. Kronners.—Chlorphenol added to fuming sulphuric acid mixed with English sulphuric

acid forms γ-chlorphenolsulphuric acid and δ-acid also. By using the undiluted acid only the first is formed.

On a new **compound from urine.**—F. Baumstark.—In normal urea of men or dogs this substance is found in very minute quantity, but under abnormal conditions it is found more abundant; *e. g.*, it was produced by feeding a dog benzoic acid. It is obtained by evaporating to a syrup, and while still warm adding a large quantity of absolute alcohol. After filtering the alcohol is evaporated, and the residue treated with ether after acidifying with hydrochloric acid. Water is added, ammonia in excess, and plumbic acetate. The filtrate is freed from lead by H_2S and again evaporated to a syrup. The urea is dissolved in alcohol and filtered off. The residue is dissolved in water, crystallized, and dried over sulphuric acid. The analysis gives as formula $C_3H_8N_2O$.

On **trymethylacetic acid.** — A. Butlerow. — This paper is principally a description of the most important salts and compounds of this acid, and the preparation of the acid itself.

The author finds that the acid obtained by Friedel by oxidation of pinacoline (acide pivalique) is identical with the synthetical trimethyl acetic acid. R. H.

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Passive state of iron.—M. A. Renard.—Showing that the degree to which ordinary nitric acid will attack iron depends greatly on the temperature and mechanical condition of the iron, as well as on the strength of the acid. Under certain conditions the acid has no effect on threads of iron, suspended in it. Other experiments, using gold or platinum and carbon in connection with the iron, give the same results as were obtained by M. Schoenbein, namely, that iron becomes passive when submitted to the action of an electric current, the positive electrode of which is iron in ordinary nitric acid.

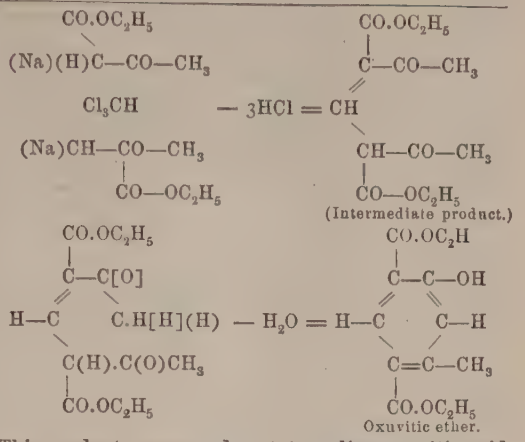
Action of chloroform on sodio-acetic ethers.—A. Oppenheim and S. Pfaff.—Sodio-acetyloacetic ether, $CHNa—(CO,CH_3)—CO_2OC_2H_5$, was discovered about ten years ago by M. Geuter, and MM. Frankland and Duppa, and it is now found that by treating it with chloroform an acid ($C_9H_8O_5$) is obtained. It is not volatile, is saponified with soda, precipitated with excess of hydrochloric acid, washed, and dissolved in warm water, and finally purified with animal charcoal and evaporated. It is soluble in alcohol and ether, very slightly soluble in cold water, and readily displaces the carbonic acid of precipitated baric carbonate, giving a crystalline salt very soluble in water. This acid is bibasic. Its barium salt is $C_9H_6BaO_5.1\frac{1}{2}H_2O$, and the calcium compound is similar. Of the others, $C_9H_6Ag_2O_5$ is flocculent and slightly soluble in water; $C_9H_6CuO_5$ is green and almost insoluble in cold water; $C_9H_6K_2O_5.H_2O$ crystallizes imperfectly. These salts, when dry, regain their water of crystallization on exposure to the air. Ferric salts give deep red precipitate with the baric salt. A drop of chloride of iron with the free acid gives a purple hue similar to the reaction of some members of the aromatic series.

On distilling the baric salt with an excess of lime, creosol was obtained. This new acid is really oxuvitic acid, differing only slightly from the well-known bibasic aromatic acid, uvitic acid—

$C_6H_3\{CH_3, CO.OH, CO.OH$ — Uvitic acid.

$C_6H_2\{OH, CH_3, CO.OH, CO.OH$ — Oxuvitic acid.

M. Baeyer has obtained toluol from nitric acid corresponding to cresol above. The following formulæ explain the reaction by which the product is obtained.



This product corresponds not to ordinary uvitic acid, but an isomer of it. Other interesting compounds have been obtained by substituting for chloroform carbon tetrachloride, chloropicrin, trichloracetic ether, and other compounds similar in composition to chloroform. These are to be further discussed. In conclusion, attention is called to $C_8H_5O_4$ anhydrous acetic acid, one of the products obtained. It probably belongs to the aromatic series—

$$C_6H_3\{OCH_3, OH, CO_2H \quad \text{or} \quad C_6H_2\{CH_3, OH_2, CO_2H.$$

Note on the **isomeric compounds, C_2H_4IBr.**—C. Friedel.—The writer, regarding the study of isomeric compounds as having an important bearing on the atomic theory, has repeated and extended the work of Lagermarck, Reboul, and others, who maintain that there are three or *even more* isomers, C_2H_4IBr, and, in common with M. Gargaime, has come to the conclusion that there are not more than two—

CH_2I
CH_2Br — Iodobromide of ethylene.

CH_3
$CHIBr$, — Iodobromide of ethylidene.

but that simple iodides or bromides are likely to be formed at the same time, somewhat modifying their properties, and leading to the above conclusions of Lagermarck and others.

On the **development of heat** produced by the contact of sulphate of soda and water at temperatures so high that the hydrates cannot exist, and a saturated solution deposits the salt only in an anhydrous state.—M. de Coppet.—After a careful series of experiments with the thermometer at different temperatures, the writer arrives at the conclusion that the heat developed is not, as is generally supposed, due to the formation of a hydrate, but that the salt undergoes a partial decomposition or modification of its composition; and he thinks the same is true of several other salts, as carbonate of soda, nitrates of soda, ammonia, silver, etc.

Ethers of normal propyl glycol.—E. Reboul.—Normal bromide of propylene, $CH_2Br—CH_2—CH_2Br$, when treated with potassic acetate and alcohol, gives propylenic diacetate, containing only slight traces of the monoacetate. This, after saponification with baric hydrate, washing with absolute alcohol, redistilling, etc., gives pure normal propyl glycol, a thick colorless liquid of sweet taste, density 1·053 at + 19° C., boiling at 216° (4° correction), soluble in water and alcohol in all proportions.

Diacetate, $CH_2.C_2H_3O_2—CH_2—CH_2.C_2H_3O_2$. — A colorless, oily liquid with slight acetic odor, 1·070 at + 19°, boiling at 209–210°, and soluble in eight to ten parts of

water. May be produced as above, or from argentic acetate and normal bromide of propylene.

Dibenzoate, $CH_2.C_7H_5O_2—CH_2—CH_2.C_7H_5O_2$.—Easily obtained from argentic benzoate, and the normal bromide, with the addition of anhydrous ether. Liquid at first, but changes to a crystalline mass. Melts at +53°, but is liquid far below its point of fusion. Easily broken up by baryta into benzoate, and normal propyl glycol.

Valerines.—Propylenic monoalerine and divalerine with valeric acid have been obtained by means of valerate of silver.

Chlorhydrines.—Propylenic monochlorhydrine and dichlorhydrine have also been obtained by treating normal propyl glycol with dry chorhydric acid gas. The monochlorhydrine ($CH_2.OH—CH_2—CH_2.Cl$) is an oily liquid, 1·132 at +17°, boiling at 160°, soluble in twice its volume of water.

Oxide of normal propylene and polyoxypropylenes.—By treating the monochlorhydrine with potash, rectifying, etc., these products are obtained, and will be further considered hereafter.

Note on the **composition of permanganate of potassa.**—E. J. Maumené.—Two proofs are here brought forward to establish the fact that the composition of this salt is $Mn_2O_7.KO$, and not $Mn_2O_6.KO.HO$; first, that it does not lose any appreciable amount of water by heat; and, second, the determination of CO_2 on treatment with excess of oxalic acid.

(1) $Mn_2O_6 + 4C_2O_3 = 8CO_2 + 2MnO$
(2) $Mn_2O_7 + 5C_2O_3 = 10CO_2 + 2MnO$.

(2) is shown to be the reation that actually takes place.

A new method of **treating metals or their oxides.**—The instability of the different oxides has always been a source of trouble, and reduction by hydrogen is open to objections. These difficulties may be avoided by treating the oxide (after destruction of the filter) with sulphuric acid, heating to bring it into the condition of sulphate, and thus determined. To avoid absorption of atmospheric moisture, add to the sulphate a known weight of paraffine, or some similar substance, fusible and not volatile at 200° or 300°.

No. 4.

Researches on explosive bodies. Explosion of powder.—Noble and F. A. Abel. Memoir I. Extract.—Not suitable for abstraction.

On the production, in the same solution, and at the same temperature, of two varieties of **sulphur, octahedral and prismatic.**—D. Gernez.—The writer has succeeded in producing either of these varieties at pleasure, by suspending in the solution a germ crystal of the kind desired.

On the action of **ether, changing cupric dioxide to protoxide** and metallic copper.—Aug. Guerout.—Showing that, at a high temperature, ether acts as a reducing agent on the oxides of copper.

On **isoterebenthene.**—J. Riban.—Showing how this isomer may be formed from ordinary terebenthene, and giving its properties. The monochlorhydrate of isoterebenthene is also obtained, and the carbide itself reformed by treating the monochlorhydrate with an alcoholic solution of potash at 100°. Dichlorhydrate is also obtained, and, lastly, isoterebenthene, $C_{10}H_{16}$, is converted into cymene, $C_{10}H_{14}$, by transforming into bibromide, and decomposing by distillation over solid caustic potash. It is remarkable that the cymene formed in this case is exactly the same compound as is obtained from terebenthene and terebene.

On the **decomposition of the fibrin of the blood** with the formation of a substance similar to ordinary albumen.—Am. Gautier.—Fibrin dissolved in sea-water has long been known to undergo a change, and has been thought to become a substance intermediate between albumen and casein, but it is now shown, by slightly altering the conditions and analyzing the product, that the product formed possesses the composition and many of the properties of ordinary albumen. Besides the albumen a second product of great interest is formed, rich in phosphate of lime and magnesia. This will be hereafter considered.

On the **antiseptic properties of the heavy coal oils.**—L. Dusart.—Strongly recommending the use of these tar oils, as being effective, cheap, and convenient, and giving examples of successful results obtained by their use.

New process for the manufacture of the so-called **"alumed" plaster,** or stucco.—Showing how simple sulphuric acid may be substituted for alum in this manufacture, and the process much simplified thereby. The effect of the alum was to change the carbonate of lime into the sulphate, and this can now be more conveniently done by means of sulphuric acid.

On the **decomposition of albuminous substances** in a vacuum.—N. Grehant and E. Modrzewski have commenced a series of investigations on this subject, and in this paper describe their apparatus, and give some of their results.

On the **phosphates of lime** of Ciply in Belgium.—M. Nivoit.—Giving the result of several analyses of them, showing carbonate of lime to be present in great quantity, requiring, therefore, much acid to be consumed in preparing superphosphates. J. M. M.

Archiv der Pharmacie.

November, 1873.

Potable water of the city of Bayreuth.—Ernst Spiess.—An examination of several kinds of water, some having their origin outside the city in the Muschelkalk, Keuper and Bunter sandstone formations, while others have their origin within the city. The general conclusion is, that water brought from a distance contains less organic matter, nitric acid, and chlorine, than water in wells within a city's limits, and is therefore to be preferred for health.

An oxidation product of **caryophyllin.**—E. Mylius.—Caryophyllin, to which Muspratt, Dumas, and Mylius have given the empirical formula $C_{10}H_{16}O$, seems to be nearly related to camphor. Its physical properties, however, appear to indicate that its molecule is twice as large as that of camphor; for, while the boiling point of the latter is not far from 225°, the melting point of caryophyllin is 285°, and its boiling point above that of mercury. Like camphor, it is acted on by HNO_3, and caryophyllic acid ($C_{20}H_{32}O_6$) is formed. This acid is white, crystallizes out of fuming HNO_3 in needles united in the form of a brush; it is soluble in ether, alcohol, and acetic acid, but difficultly soluble in water. It dissolves also readily in NH_3, and in solutions of the alkaline carbonates, with a yellow color. The sodium, silver, and barium salts have been prepared.

Detection of ammonia.—G. C. Wittstein.—Einbrodt first suggested the use of mercuric chloride as a reagent for ammonia, and this, the writer contends, is far better than the Nessler test. The following experiment he cites as proving it. To 100 c. c. of water add 1 drop of NH_4Cl, a drop of HKO, and a drop of mercuric chloride. A distinct white opalescence will appear. To another 100 c. c. of water, add also a drop of NH_4Cl, and 5 drops of the Nessler reagent. In this case neither coloration nor turbidity will be produced.

On the test and **composition of flesh extract.**—E. Reichardt.—According to Liebig flesh extract should contain at least 60% of soluble matter in alcohol of 80%. The specimens examined by the writer, which were from two different manufacturers, contained from 80% to 81% of soluble matter, and this was very constant in its composition. It contained water 16% to 17%, fat and albumen none, nitrogen 9·5+ %, ashes 21+ %. The ashes contained 6% of phosphoric acid, 9% of potash, and 2% of soda. The proportions are so constant, any adulteration could easily be detected.

Rare **photographic chemicals.**—Dr. J. Schnauss.—Nitrate of uranium is mentioned as good, particularly in copying when gold or silver salts are used. The sesquioxide of uranium is reduced by certain organic substances under the influence of sunlight to protoxide, and then this reduces gold or silver from their salts. Peroxide of hydrogen is also used with advantage to destroy the last traces of sodium hyposulphite.

The value of an **alkaline silver solution for determining the organic matter in water.**—J. C. Blass.—The writer assumes that water containing organic matter not easily destructible is not injurious to health, and that a silver solution, which is reduced by easily destructible organic matter, but not by that difficultly destructible, is better suited than potassium permanganate for testing the sanitary quality of water.

Food of the North American Indians.—J. R. Dodge.—A further enumeration of articles used as food by the Indians is given; for instance, berries, fleshy fruits of several species of cactus, seeds of various kinds, especially Indian corn, which is said to have been cultivated in China long before it was by the Indians; also raw flesh of various kinds, grasshoppers, ants, crickets, and the larvæ of certain flies.

A. P. S. S.

Journal de Pharmacie et de Chimie.

Preparation of **nitric anhydride.**—M. Berthelot.—By treating monohydrated nitric acid (surrounded by a freezing mixture) with phosphoric anhydride, and then distilling with great care, 60 to 70 per cent. of the theoretical amount of nitric anhydride was obtained. It can be preserved in vials closed with ground stoppers, over sulphuric acid, better than in tubes fused together. Light causes it to decompose. It evaporates slowly in the air.

On the **solubility of succinic acid in water.**—E. Bourgoin.—

100 parts of water at			0°	will contain	2·88	parts.
"	"	"	8°·5	" "	4·22	"
"	"	"	14°·5	" "	5·14	"
"	"	"	27°	" "	8·44	"
"	"	"	35°·5	" "	12·29	"
"	"	"	40°·5	" "	15·37	"
"	"	"	48°	" "	20·28	"
"	"	"	78°	" "	60·775	"
"	"	" (boiling)	100°	" "	120·86	"

The last two determinations were made by evaporating to dryness a measured quantity of solution concentrated when at the given temperature. The others were made by the more exact method of acidimetrical estimation.

Use of **metatartaric acid in preparing magnesia lemonades.**—M. Leger.—Ordinary tartaric acid, when mixed with solution of magnesia, gives a solution, clear at first, which soon becomes cloudy, and deposits a modified form of tartaric acid in combination with the magnesia. The acid has the properties of metatartaric acid, produced by heating ordinary tartaric acid to 170°. The method by heating is the mode of preparation preferred.

On **soluble Prussian blue.**—M. Sergent.—By preparing solutions which exactly equal each other so that there is no excess of either reagent when the reaction is terminated, a blue solution, instead of a blue precipitate, may be obtained. The proportions recommended are:—

Red prussiate	10·5	grammes.
Ferrous sulphate	9·0	"
Distilled water	1000·0	"

April.

Memoir on the **role of phosphorus and phosphates in putrefaction.**—Jules Lefort.—The presence of phosphorus or some one of its compounds has been observed to be one necessary condition for the development of putrefaction. The more phosphorus the more rapid the putrefaction. The bad odor is supposed to be owing to the escape of phosphoretted hydrogen, and to the same compound is attributed the luminosity of putrescent matter under some circumstances. On passing the gases evolved from putrefying matter through argentic nitrate, no phosphorus compound of silver was found, although the gases were completely deodorized by passage through the silver solution.

May.

New researches on the **physiological exhaustion of beer-yeast,** and remarks with regard to a recent communication of M. Schutzenberger on the same subject.—A. Bechamp.—Yeast in becoming exhausted was found to produce:—

1st. Volatile products; alcohol, acetic acid, carbonic acid, and at the end nitrogen.

2d. Fixed products; A. Mineral substances, sulphuric acid, phosphoric acid, potassa, soda, magnesia. B. Organic substances, zymose, albumen, gummy substances, with dextro-rotatory power, leucine, tyrosine, syrupy residue.

Fresh yeast contains no tyrosine or leucine, these substances being the products of a special function of the cellule.

On the analytic and **toxicological examination for aniline.**—E. Jacquemin.—The mode of treating blood, etc., for the extraction of aniline, where its presence is suspected, is given in detail. The sodic hypochlorite reaction is considered preferable. The tests with sulphuric acid and potassic chlorate or nitrate, and with sulphuric acid and potassic bichromate are mentioned and commented upon.

On **titred solutions of potassic permanganate.**—M. Berthelot.—The mode of titration by pure oxalic acid is stated to be the only correct method.

Separation and **estimation of the cinchona alkaloids.**—M. de Vry.—Take 5 grammes of pulverized bark, treat with 50 grammes of ether, agitate, let it stand for one day; the liquid contains the quinine and amorphous alkaloid, with traces of quinidine and cinchonine. The undissolved portion contains the cinchonine, cinchonidine, and the quinidine; filter and wash the residue with a little ether.

Evaporate the solution, and dissolve the residue in 10 parts strong alcohol acidulated with one-twentieth of sulphuric acid, add alcoholic solution of iodine so long as a precipitate of quinine iodosulphate is produced, filter, wash with strong alcohol, and dry on sand bath. One part of the iodosulphate contains 0·565 of quinine. The filtrate is treated by an alcoholic solution of sulphurous acid, which changes the iodo-sulphate to iodohydrate and decolorizes the solution. Heat on the sand bath, and precipitate with a slight excess of sodic carbonate; the precipitate is the amorphous alkaloid. The

portion insoluble in ether is treated with 40 parts boiling water. Saturate gradually with dilute sulphuric acid, add a solution of Rochelle salt, agitate, and let it stand one day; cinchonidine tartrate crystallizes out. Filter, wash with a little water, and dry at 100°; one part contains 0·804 cinchonidine. The filtrate is mixed with potassic iodide and agitated. Quinidine iodhydrate precipitates, which is filtered off and washed with a little cold water; one part contains 0·718 of quinidine.

June.

On the **analytical and toxicological examination for aniline.**—E. Jacquemin.—The reaction of aniline with sulphuric, chromic, iodic, and fuming nitric acid, and that with aniline oxalate, and arsenic acid, are discussed.

On **anti-fermenting substances.**—M. Petit.—The action of metalloids, of acids, of bases, of mineral salts, of salts containing organic acids, of organic alkaloids, and of various neutral substances, is reviewed in brief. These substances are classed as follows:—

1. Anti-fermenting by the modifying action on the ferment globules—alkalies, and concentrated acids, concentrated solution of different salts, sodium chloride, sodic acetate, sal ammoniac, potassic acetate.
2. Anti-fermenting by direct or indirect oxidation—potassic permanganate, chlorine, bromine, iodine.
3. Anti-fermenting by chemical combination proper—salts of mercury, copper, and silver.
4. Anti-fermenting by influence on the medium (acid and alkaline solutions but little concentrated), but interfering with fermentation.
5. Anti-fermenting proper—hydrocyanic acid, oxalic acid, chloroform, free sulphurous acid.

On **ammonia nitrite.**—M. Berthelot.—This salt may be prepared directly by causing nitric oxide (NO_2), oxygen, and ammonia gas to act upon one another in a vessel placed in a refrigerating mixture. Some nitrogen is formed according to the following reaction:—

$$NO_2 + O + NH_3 = N_2 + 3HO.$$

Side by side with this, however, proceeds the formation of the salt,

$$3(NO_2 + O + NH_3 + HO) = 3(NO_4H.N.H_3).$$

Action of **bromine on bibromosuccinic acid.**—E. Bourgoin.—Bibromosuccinic acid $C_8H_3Br_3O_8$ was obtained. Its solubility in water at 17° is 7·68 parts in 100.

Influence of the **presence of nitrogen** in the fibre on the direct **fixation of aniline colors.**—E. Jacquemin.—The presence of nitrogen in a fibre appears to be of great importance in causing it to take coloring matters—*e. g.*, gun-cotton will take up and hold aniline colors without requiring any mordant. The presence of nitrogen in organic combination does not always have this effect—as, for instance, oxamide could not be made to absorb aniline colors.

On the **combination of lime and glycerine.**—M. Carles.—One litre of distilled water will dissolve 1·25 grammes of lime. If, however, the water contains 100 grammes of glycerine, more than double that amount, 3·58 grammes are dissolved. 200 grammes of glycerine cause a still larger amount of lime to be dissolved. But with the use of more glycerine than this, the amount dissolved is irregularly inverse to the quantity of glycerine used. This is explained by supposing that a combination between the glycerine and the lime is very soluble in water, but much less so in glycerine itself. It is recommended that these facts should be taken advantage of in chemistry, pharmacy, and therapeutics.

On the **falsification of beeswax.**—L. Donath.—The adulterants generally used are paraffine, stearic acid, Japan wax, and resin. The modes of detecting them are commented upon.

July.

On **refrigerating mixtures.**—M. Berthelot.—Those prepared with sulphuric acid are more particularly described.

Pyrogallol in presence of iron salts.—E. Jacquemin.—The blue color is stated not to be due to the presence of free acid. A new base, "pyrogalloferric," is believed to be formed. The action with different ferric salts is described. Ferric acetate, heated for some hours on the water-bath, loses the property of giving a blue color with either potassic ferrocyanide or pyrogallol.

New researches on **black phosphorus.**—M. Blondlot.—Mercury is stated to be the cause of this appearance of phosphorus.

Note on **albuminoid substances.**—A. Commaille.—The albuminoids are considered by the author as quaternary compounds, as amides of leucine and tyrosine.

On the **role of salts in the action of potable waters on lead.**—M. Fordos.—All the phenomena observed are explained if the formation of lead oxide by aërated water is admitted. The action of various salts is described.

Note on the **purification of cerebrine.**—E. Bourgoin.—The cerebrine is extracted as usual from the brain by the action of alcohol and ether. It still contains phosphorus, and is purified as follows: alcohol of 90° is added, and the temperature is slowly and gradually raised. The cerebrine dissolves before ebullition occurs, and a viscous mass, containing phosphorus, is left. The liquid is then quickly decanted, and the cerebrine is separated out by cooling. The operation may be repeated several times if an absolutely pure product is desired. The author considers cerebrine as identical with Liebrich's protagon, and analyses are quoted to show the correctness of this view.

On the **presence of ammonia as a salt in normal urine.**—M. De Vry. — By neutralizing fresh normal urine with sodic bicarbonate, filtering, and adding magnesic sulphate, a precipitate of ammonio-magnesic phosphate was obtained.

On the **buds of poplar.**—M. Piccard.—From these, beside salicine and populine, two other bodies have been obtained, called by the author chrysine and tectochrisine. The latter is homologous with the former; chrysine crystallizes in golden-yellow scales, insoluble in water, and fusing at 275°. It dissolves in 180 parts of alcohol in the cold, and in 50 parts of boiling alcohol. Tectochrisine fuses at 130°, is less soluble in alcohol, but more soluble in benzine, from which it crystallizes in sulphur-yellow crystals of clino-rhombic form.

New **reagent for blood.**—M. Sonnenschin.—Sodic tungstate, strongly acidulated with acetic or phosphoric acid, gives a voluminous precipitate with protein substances.

E. W.

Pharmaceutische Zeitschrift für Russland.

Vol. xiii. No. 7.

Litmus solution.—J. Martenson.—The author found that a litmus solution will keep perfectly well if the aqueous extract of the commercial litmus is purified by precipitation with 80 per cent. alcohol, solution of the precipitate in water, neutralization with dilute sulphuric acid, and evaporation to a syrup, separation of the mother liquor from the crystals of potassic sulphate, addition of glycerine to this deeply-colored liquid, and evaporation again.

No. 10.

The ethereal oil in the flavors of **wild rosemary** (*Ledum palustra*, L.).—J. Trapp.—The oil obtained by distillation is liquid only when fresh, and soon changes into a solid oil (Ledum camphor). This is insoluble in water, and separates with remarkable readiness from solutions in alcohol or ether, in fine large crystals. The analysis gave results corresponding to the formula $C_{28}H_{24}O$.

No. 11.

Glucose in the grain of rye and wheat.—A. Poehl.—When the grain is dried carefully at 90° C., and crushed, it yields no glucose to 95 per cent. alcohol. But if, as in all examinations hitherto made, water is present, even though no more than would be retained as hygroscopic water in the air-dried kernel, glucose is produced during the operation of crushing the seed, and is found in the alcoholic extract of the meal.

No. 12.

Adulteration of **benzoic acid**, and some facts concerning the acids in the gum benzoin of Sumatra.—A. Theegarten.—The author concluded that the adulterated acid examined was a mixture of benzoic and cinnamic acids, its ultimate composition being nearly the same as that of a mixture of one molecule each of these acids, and its melting-point, 83°–85° C., also being nearly the same as that of such a mixture. The author examined a sample of Sumatra gum benzoin, and found its acid to be mostly cinnamic acid, and he inferred that this gum had been used to adulterate the benzoic acid that he found to be so impure.

No. 13.

Detection of chloroform.—E. Rennard.—Chloroform was detected in a case of suspected poisoning, seven days after death, in the distillate from a portion of the blood, liver, and kidneys, by Hofmann's reaction (production of isonitrile), when other tests failed to give any reaction.

Clarification of the **alcoholic solution of shellac.**—A. Peltz.—One part of powdered chalk is added to the solution of one part of shellac in six of 90 per cent. alcohol, and the mixture is heated to 60° C. After several hours most of the solution will become clear, and the lower, turbid portion can be filtered easily.

No. 14.

Chemical examination of **cinnamon and cassia.**—P. Trojanowski.—The purpose of the examination was to discover some means of distinguishing one of these spices from the other in the powdered form. Quantitative estimations were made of volatile oil soluble in ether, and insoluble in ether, tannic acid, amylaceous substances, gum and ash, in several kinds of cinnamon, and of cassia bark and wood. No method of distinguishing the genuine cinnamon from cassia was found, except one based on the much larger proportion of starch in the latter, which causes it to strike a blue color with iodine water, while, with the same reagent, Ceylon cinnamon simply takes on a little darker shade of its original color. G. C. C.

Moniteur Scientifique.

No. 390. June, 1874.

On the effect of **different reagents on certain artificial coloring matters** fixed on wool, silk, and cotton.—N. Bibanow.—A collection of valuable tables, giving the reaction of acetic, hydrochloric, nitric, chromic acids, caustic soda, ammonia, sodium hydrosulphate, stannous chloride, ferric chloride, and chloride of lime upon the most frequently occurring coal tar colors for their detection.

No. 391, July.

A new fulminate with lead picrate as its base.—M. Prat.—The author has substituted a composition containing lead picrate for the fulminate of mercury ordinarily used in the percussion cap manufactory at Bordeaux. The picrate is produced by precipitating a solution of ammonium picrate with lead acetate, washing and pressing out. The still moist cake thus obtained is mixed with potassium chlorate, finely pulverized, in the proportions of equal equivalents, and made into a paste with gum tragacanth. Experiments show that while an equivalent of common powder gives 8 volumes of gas, and one of mercury fulminate gives 10 volumes, an equivalent of the picrate powder gives 36 volumes. Even for equal weights, the volumes of gas are respectively 33, 23, and 36 volumes.

No. 392, August.

Note on the theory of the formation of **nitre in Peru.**—Antony Guyard (Hugo Tamm).—The author contends that there have been in Peru sulphuric, hydrochloric, iodo-nitric, and boric epochs; that sometimes only sulphates, nitrates, chlorides, and borates were formed, sometimes only the lime salts or the soda salts, sometimes mixtures of all these; and that subsequently the salts formed reacted on each other, thus forming the nitrate deposits upon the surface.

On **lupuline.**—Griessmayer.—A description of a true alkaloid from hops. The quantity obtained was too small for an elementary analysis.

On the means for **detecting dextrose in presence of dextrin and similar bodies.**—C. Barford.—A solution of neutral copper acetate gives in the cold a reduction with dextrose, but none with dextrin.

No. 393, September.

Discovery of **crystallized digitaline.**—Ch. Natwelle.—A minute description of the method of extraction, properties, and reactions of this new crystallized alkaloid. Its elementary analysis gave, carbon 51·33, hydrogen 6·85, oxygen 41·82. An appended note gives some improvements in the process of preparation.

Determination of **gaseous sulphurous acid.**—A. Gabriel Pouchet.—The gaseous mixture is drawn through a special apparatus containing a titred solution of iodine.

No. 394, October.

A new **heliophotometer.**—F. Craveri.—An apparatus for recording the intensity of the sun's light throughout the day, by means of photographic paper moved by clock-work.

On **kawa root.**—Nölting and Kopp.—The authors have examined this root more thoroughly than had been done previously. Beside kawaïn, which they show to contain no nitrogen, another crystalline substance was discovered having the formula $C_{17}H_{17}O_5$. To kawaïn, they give the composition, carbon 66·35, hydrogen 5·21, oxygen 28·44 = 100. Nitric acid oxidizes kawaïn to benzoic and nitrobenzoic acids.

On a **new coloring matter termed grenade.**—A dye from fuchsine residues, giving to silks a pure garnet color.

On Persoz's process for preparing **lubricants for machinery.**—This process, patented in France, November 3, 1873, consists in dissolving fats, or better fatty acid, or even resins, in the heavy mineral oils, and then forming a soap by the addition of an alkali.

G. F. B.

Journal of the Chemical Society.

Series ii., vol. xii., May, 1874.

On the **action of bromine on alizarin.**—W. H. Perkin.—When dry alizarin is heated with a solution of bromine in CS_2 in sealed tubes to 180°–190°, for four or five hours, mono-bromalizarin is obtained, after recrystallization from glacial acetic acid, as orange-colored needles. The author also describes diacetobromalizarin, formed by heating the former with acetic oxide. Nitric acid oxidizes bromalizarin to phthalic and oxalic acids. As a dye, bromalizarin resembles alizarin, but the reds are less purple and the purples less blue than those given by alizarin.

On the action of **triacetyl chloride upon urea.**—Meldola and Tommasi.—Yields trichloracetyl urea having the formula $CO\begin{matrix}NH(C_2Cl_3O)\\NH_2\end{matrix}$.

Researches on the action of the **copper-zinc couple on organic bodies.**—Part V. On the bromides of the olefines.—Gladstone and Tribe.—With ethylene bromide the action is as follows (both with and without the presence of alcohol or water) :—

$$C_2H_4Br + Zn = ZnBr_2 + C_2H_4.$$

Propylene and amylene bromides act similarly. The action of the couple upon the olefine bromides is therefore quite different from its action upon the alcohol-radical bromides.

Part VI. On ethyl bromide.—The result was entirely analogous to that of ethyl iodide. Alone, ethylo-bromide of zinc is formed, and then this decomposes, forming zinc-ethel and zinc bromide, or even C_2H_6 and C_2H_4. When water is present—

$$\left.\begin{matrix}C_2H_5\\Br\end{matrix}\right\} Zn + H_2O = \left.\begin{matrix}HO\\Br\end{matrix}\right\} Zn + C_2H_6.$$

Alcohol gives—

$$\left.\begin{matrix}C_2H_5\\Br\end{matrix}\right\} Zn + \left.\begin{matrix}C_2H_5\\H\end{matrix}\right\} O = \left.\begin{matrix}C_2H_5O\\Br\end{matrix}\right\} Zn + C_2H_6.$$

The **agglomeration of finely-divided metals by hydrogen.**—Alfred Tribe.—An observation that finely-divided copper, palladium, and platinum are agglomerated to a sponge-like mass when placed in contact with nascent hydrogen. "The minute metallic particles, in virtue of a species of adhesive attraction, become surrounded by films or layers of liquid hydrogen, the coalescence of these films producing the spontaneous inward movement of the finely-divided metal which is characteristic of agglomeration."

On the **spontaneous combustibility of charcoal.**—Andrew Fuller Hargreaves.—The conclusion is that charcoal absorbs its maximum amount of oxygen from the atmosphere within three days after carbonization, and that after that time no danger need be apprehended in using it, while up to that time its use may be attended with danger.

June.

On the **cobalt bromides and iodides.**—W. N. Hartley.—Describing cobalt bromide as (1) a crystalline hydrate, $CoBr_2.6H_2O$, in large deliquescent and efflorescent purple-red prisms; (2), a deliquescent crystalline hydrate, $CoBr_2.2H_2O$, purple or blue in color; and (3), a vivid green deliquescent, amorphous, and anhydrous salt, $CoBr_2$; and cobalt iodide, CoI_2; and similar hydrates.

On the **solubility of plumbic chloride in glycerin.**—C. H. Piesse.—Pure glycerin dissolves 1·995 per cent. of plumbic chloride; mixed with 50, with 75, and with 87·5 per cent. of water, the glycerin dissolved 1·32, 1·036, and 0·91 per cent. of plumbic chloride respectively.

On the products of the **decomposition of castor oil.**—No. 2. On the distillation of sodium ricinoleate.—E. Neison.—Confirming the statement of Bonis, that octyl aldehyde (methylœnanthol) is the product of the distillation of sodium ricinoleate. The statement of Städeler, that heptyl aldehyde is the product of this distillation, was due to the deficiency of alkali in the ricinoleate employed.

On a **reaction of gallic acid.**—H. R. Procter.—On the addition of sodium or potassium arsenite, faintly alkaline, to a solution of gallic acid, an intense green color is developed.

On ozone as a concomitant of the **oxidation of the essential oils.**—C. T. Kingzett.—In this paper the author proves that neither ozone nor hydrogen peroxide is produced during the oxidation of essential oils in sunlight, but that the active properties acquired by the turpentine, etc., seem to be due to the formation of a turpentine hydrate, $C_{10}H_{16}O,H_2$.

July.

Note on a **new mineral from New Caledonia.**—A. Liversidge.—An amorphous apple-green mineral, having the formula—

$$(\dot{M}g\dot{N}i)_{10}\ddot{S}i + 3\dot{H},$$

and which the author calls *caledonite.*

On the action of the **copper-zinc couple on the chlorides of ethylidene and ethylene.**—J. H. Gladstone and A. Tribe.—This action distinguishes clearly between these two isomers, and properly characterizes them.

Isomeric terpenes and their derivatives.—Part IV. § 1. On cajeput oil.—C. R. A. Wright and T. Lambert.—Showing that the cymene obtained from it by treatment with bromine and subsequent distillation was identical with that yielded by the other terpenes.

§ 2. On the action of **pentasulphide of phosphorus on terpenes** and their derivatives.—C. R. A. Wright.—Acts similarly on all, producing cymene.

Action of **ammonia on phenyl-chloracetamide** and cresyl-chloracetamide.—D. Tommasi.—Produces phenyl-hydroxyl-acetamide $\left.\begin{matrix}C_6H_5\\H\\CH_2OH.CO\end{matrix}\right\}N$, and cresyl-hydroxyl-acetamide $\left.\begin{matrix}C_7H_7\\H\\CH_2OH.CO\end{matrix}\right\}N$.

On **aqua regia and the nitrosyl chlorides.**—W. A. Tilden.—The gases from aqua regia were passed into sulphuric acid to saturation, and on treating the acid with sodium chloride, pure nitrosyl chloride, NOCl, comes over. No other chloride could be obtained.

On the preparation of **ethyl chloride and its homologues.**—Hydrochloric acid gas is passed into alcohol containing half its weight of fused zinc chloride, and the ethyl chloride evolved is collected in cooled alcohol, which at 16° absorbs half its weight. The same process may be used with methyl and amyl alcohols.

August.

On **ipomæic acid.**—E. Neison and J. Bayne.—Proving that the ipomæic acid of Mayer, obtained from jalapin by the action of nitric acid, is in reality only sebacic acid.

On **New Zealand Kauri gum.**—M. M. P. Muir.—This substance exudes from a tree, *Dammara Australis*, and 52 per cent. of it is soluble in alcohol. The author classes it as a gum-resin.

On certain compounds of **albumin with the acids.**—G. S. Johnson.—Establishes, apparently, the following

points: (1) The existence of definite compounds of albumin with the acids in definite molecular ratios; (2) The applicability of dialysis to the ready and accurate preparations of these compounds; (3) Probable correctness of the formulas of Lieberkuhn, Loew, or Liebig.

On a simple method of **estimating urea in urine.**—W. J. Russell.—A modification of Hüfner's method, using sodium hypobromite and collecting the nitrogen evolved in a graduated tube. A convenient apparatus for the purpose is figured in the article.

Dendritic spots in paper.—H. Adrian.—Confirming the view of Livesidge, that these spots are due to copper sulphide, and suggesting that they are formed by the action of the antichlor upon bits of copper from the wirework on which the paper is made; the sulphide passing in lines of least resistance and thus assuming the dendritic form.

September.

On the products of the **decomposition of castor oil.**—No. 3. On the decomposition by means of alkali-hydrate.—E. Neison.—The sole product of the decomposition of sodium ricinoleate, by distillation with an excess of sodium hydrate, consists of a secondary octylic alcohol, namely, methyl-hexyl-carbinol, and the corresponding ketone, methyl-hexyl-ketone, without any heptyl alcohol.

On the action of **nitrosyl chloride on organic bodies.**—Part I. On phenol.—W. A. Tilden. It appears to oxidize the phenol to quinone, which is then converted into chlorinated quinones, mainly chloranil, the nitrosyl chloride itself suffering reduction, not merely to nitric oxide or nitrogen, but being actually converted in great part into ammonium chloride.

Aniline and its homologues, etc., in coal-tar oils. W. Smith.—The oils known as the light coal-tar oils, varying in specific gravity from 0·9 to 1·0, are those which appear to contain aniline in largest quantity. The oils obtained from the crude benzol are larger in quantity than from the other sources, but contain less aniline.

On the action of chlorine, bromine, etc., upon **isodinaphthyl.**—W. Smith and J. M. Poynting.—Chlorine produces, from isodinaphthyl $C_{20}H_{14}$, the tetrachloride $C_{20}H_{10}Cl_4$, bromine a heptabromide $C_{20}H_7Br_7$, and sulphuric acid a sulpho-iso-dinaphthalic acid strongly fluorescent.

On **hydrogen persulphide.**—W. Ramsay.—The results obtained confirm those of Hofmann, that in the strychnine compound, the hydrogen persulphide has the formula H_2S_3. All attempts to isolate it from this compound failed, and the analysis of the compound prepared directly varied from H_2S_7 to H_2S_{10}. It is an almost colorless oil, with an irritating odor like H_2S, and a specific gravity of 1·7342. G. F. B.

Journal für Landwirthschaft.

January to March, 1874.

Absorption and secretion of the nutritive constituents of fodder in the digestive organs of the sheep.—E. Wildt.—Taking advantage of the fact that silicic acid is absorbed, to a very slight extent, the author attempted to ascertain what proportion of each organic and each inorganic constituent of the fodder is absorbed as it moves on through the stomachs and intestines, by comparing the respective amounts of each of these constituents with that of the silica in the fodder originally, and in the contents of different parts of the digestive organs. For the interesting results obtained we must refer to the original article.

The estimation of **soluble phosphoric acid in superphosphates.**—M. Fleischer and A. Müller.—Results the same as those given by Abesser Jani and Märcker (*Fresenius' Zeitschrift*, xii. 239) with regard to the necessity of precipitating the phosphoric acid by a magnesia mixture made with magnesic chloride instead of the sulphate. As regards the preparation of the aqueous extract of the superphosphate for analysis, several methods in common use were compared, and it was found that all gave very nearly the same results; and, further, that in most cases all the acid phosphate goes into solution in a very short time, no more being taken up by the water in twenty-four hours than in half an hour; it was also found that the correction that is made in some of these methods for the volume of the superphosphate taken is not only unnecessary, but may lead to erroneous results. It was further proved, as shown by Abesser Jani and Marcker, that the solution of uranic acetate should be standardized by a solution of superphosphate of lime of known strength, the results being too low if a solution of an alkaline phosphate is used.

The **nitrogenous food of plants.**—F. Bente.—Maize plants grown by the method of water culture were found to be able to assimilate nitrogen from asparagus and from acetamids in a perfectly normal manner.

G. C. C.

Dingler's Polytechnisches Journal.

Vol. 209, No. 6.

On the **carbonization of wood** in close vessels.—R. T. Von Reichenbach in Vienna.—It is recommended to conduct the process of charring the wood only so far that so-called red char is obtained, when the yield of acetic acid is largest, and very little tar and gas are formed. Some details about the yield of acetic acid and tar, about the production of concentrated acetic acid and sugar of lead, and the cost of production, are given. —*Württembergisches Gewerbeblatt.*

Vol. 210, No. 1.

On the fabrication of **oxalic acid from bran, sawdust, and lignose.**—Wm. Thorn.—By fusing sawdust with sodium hydrate alone, from 31·60 to 52·14 per cent. of oxalic acid were obtained according to the temperature (180° to 240°) and thickness of the layer; sawdust heated with a mixture of 40 KOH and 60 NaOH to 240–250° in thin layers yields about 80 per cent. of oxalic acid (which is as much as with KOH alone), but considerably less when heated either in thick layers or with a different mixture of soda and potassa. Neither the passage of warm air over the heated mass nor the addition of binoxide of manganese increased the yield of oxalic acid, which was always largest when soft woods were used. The best proportion for practical working is 50 parts of wood to 100 parts of alkali hydrate. The fused mass is lixiviated, concentrated to 1·35 sp. gr., and cooled, when the sodium oxalate crystallizes. This is converted into the calcium salt, decomposed by sulphuric acid (it requires 3 equivalents) and crystallized. For the recovery of the alkalies, the lyes are mixed with sawdust, calcined, lixiviated, rendered caustic by lime, and concentrated. Bran has no advantage over sawdust, but is much higher in price; and if the temperature is raised sufficiently high, no difference in the yield of oxalic acid is perceptible. Lignose (*i. e.* wood treated with boiling dilute acid) yields considerably less oxalic acid than wood.

Precipitated gold.—P. Weisskopf.—By precipitating the gold with grape sugar and caustic soda, it is obtained

in a much finer state of division than by other processes, is easily polished, and well adapted for use on porcelain, etc.

Cement for gas-retorts.—Mixtures of loam, graphite, and borax, and of 5 parts (by volume) of powdered glass, 5 parts fire-clay, 1 part powdered borax, are recommended.

Detection of **picric acid in beer.**—H. Brunner.—The beer is acidulated by chlorhydric acid, heated on the water-bath, and any picric acid precipitated on wool; the wool is warmed with dilute ammonia liquor, the filtered solutions concentrated on the water-bath, and a few drops of potassium cyanide solution added. The presence of even only a trace of picric acid is indicated by a red coloration produced by potassium isopurpurate.—*Pharm. Post.*

Determination of **sulphur in pig-iron**, wrought-iron, and steel.—M. Koppmayer.—The author dissolves in hydrochloric acid, passes the sulphuretted hydrogen through a titred solution of iodine in potassium iodide, and determines the excess of iodine by a titred solution of sodium hyposulphite.

No. 5.

The manufacture of **alum** in Montioni.—C. M. Kurtz.—The alunite is assorted and roasted in kilns until acid fumes make their appearance; the roasted mass is piled about ½ metre high, during a long period (up to forty days), moistened with water, extracted with hot water, and crystallized in tanks two metres long, wide, and deep.

No. 6.

The application of **soluble glass in building.**—G. Feichtinger.—For the painting of brickwork, sandstone, and plastered walls, the author recommends paints which are made by mixing the colors with a solution of potassium and sodium silicate, but the plastering must not be fresh, that the caustic lime may not decompose the silicate. M. A.

Polytechnisches Notizblatt.

No. 9, 1874.

On the **regeneration of oil paintings.**—Dr. Weigelt.—A current of air is blown through a vessel of warm alcohol, and then directed upon the painting. The vapor borne along by the air softens the varnish, and restores it to its original beauty.

On the influence of **thymol on some animal ferments.**—Peschechowo.—Experiments made by Sulima-Samuillo prove that lactic and alcoholic fermentations are both stopped by the use of thymol. It is also found to be an excellent substitute for carbolic acid for sores, gangrene, etc., being free from the repulsive odor of that powerful disinfectant.

Fig coffee.—Roasted figs are said to furnish a much better substitute for coffee than chicory. When mixed with equal parts of genuine coffee it is a much healthier beverage, and quite as pleasant as pure coffee.

A new test for iodates.—Egidio Pollacci.—The solution to be tested is placed in a test-glass, and a thin piece of phosphorus thrown in. If an iodate is present, the reaction begins almost instantly, and the liquid about the phosphorus turns dark-brown. If phosphorus is employed which has turned white and opaque in the light, the reduction requires a moment or two. If the quantity of iodate is not too small, visible, glittering crystals of iodine will attach themselves to the phosphorus, and to the bottom of the glass. Red amorphous phosphorus acts more energetically than ordinary phosphorus. The reaction cannot take place in the presence of free alkali.

No. 10.

Some uses of **vegetable parchment.**—Prof. August Vogel.—Particular notice is taken of its use in dialysis for separating quinine, strychnine, and other crystallizable alkaloids from colloids. The preparation of allaxan, creatin, asparagin, etc., is described. Dialysis is especially useful in the analysis of beer.

Testing for **lead in water.**—Mayençon and Bergeret.—Plumbic sulphide is slightly soluble in soft water, and in water containing an excess of sulphydric acid. If an excess of this gas be passed through a lead solution and then filtered, the clear filtrate will contain lead, as can be proved by passing a galvanic current through it, when the negative platinum electrode will be found covered with lead. It is converted into chloride, and tested by potassic iodide.

To cover cords, pictures, and the like, with an insoluble film of glue.—To protect pictures from dust and dirt they may be coated with glue, alumina, and ox-gall, prepared as therein described.

Action of different substances in the **preservation of eggs.**—F. C. Calvert.—In dry oxygen gas eggs are unaffected unless punctured. Moist oxygen decomposes the eggs. In moist nitrogen eggs will keep three months. Hydrogen the same. Eggs, whether pierced or whole, were perfectly preserved in carbonic acid, dry or moist. Illuminating gas the same. In chlorine water (1 to 500) eggs kept eight months in a closed vessel. In a solution of dilute chloride of lime, eggs would not keep ten days. Lime-water and sulphite of lime kept them a little longer. Carbolic acid solution (1 to 500) preserved them about six weeks.

Determining the **value of milk.**—Prof. Aug. Vogel.—The author calls attention to the optical milk test. A graduated vessel with parallel sides is filled to a certain mark with water (exactly 100 c. c.). The milk to be tested is added from a graduated pipette until the mixture becomes so dense that the light no longer passes through it. A table which accompanies the instrument gives the percentage of fat in the milk.

Pressed coal.—An artificial fuel is prepared by Eckert & Co., in Frankfurt a. M., from pure wood charcoal possessing several advantages over the ordinary charcoal.

Preparation of **hydrogen gas.**—Dr. Julius Löwe.—The author introduced cupric sulphate into the hydrogen generator with the zinc. The H_2S formed is decomposed in the apparatus. More of the copper salt is added from time to time to give it a blue color. E. J. H.

RECENT CHEMICAL PATENTS.

July 7th, 1874.

152,746.—Treatment of Cod-liver Oil.—J. G. Hava, New Orleans, La. A solution of gelatinous tribasic phosphate of lime by means of a current of carbonic-acid gas.

152,763.—Process for Clarifying Sugar.—Johann Nassian, Sztrazsa, Hungary, Austria.

152,790.—Explosive Compounds.—C. A. Browne and I. S. Browne, North Adams, Mass. Fulminate of mercury, antimony, and sulphide of antimony.

152,814.—Surfacing Sheet-iron to resemble Russia Iron.—J. Stackhouse, Alleghany, Pa. Solution of oxalic acid.

152,845.—Producing Caustic Alkalies from Carbonates.—C. and J. Juron and A. and L. Imbert, Lyons, France. Carbonates treated with superheated steam.

152,889.—Funnels.—S. H. Whitley, Brooklyn, N. Y.

July 14th.

152,898.—Cleaning Carpets.—R. B. Coulter and Jeff. Pratt, Pittsburg, Pa.

152,903.—Treating Textile Fabrics to prevent Mildew and Decay.—Adolph Gruder and W. Thilmary, Cleveland, O. Sulphate of copper and chloride of barium.

153,004.—Manufacture of Friction Matches.—J. J. Machado, Havana, Cuba. Sticks dipped half an inch in compound of chlorate of potash, peroxide of manganese, glue, benzoin, and water. Afterwards tipped with sulphide of antimony and bichromate of potash; waterproofed by alcohol and tannic acid

153,035.—Compound for the Prevention and Removal of Incrustations in Steam-boilers.—I. Bernhard, Paris, France. Animal gall, glue, and phenol.

153,055 —Apparatus for Purifying Alcohol.—L. Reine Raoul, Comte de Beaurepaire de Louvagny, Grivesnes, France.

153,057.—Self-condensing Gas Generator.—N. H. Edgerton, Philadelphia, Pa.

153,123 —Compounds for Cleaning Metals and for other Purposes.—T. C. Smith, Brooklyn, N. Y.

July 21st.

153,154.—Alloys to resemble silver.—M. H. Campbell, Syracuse, N. Y Tin, bismuth, antimony, and nickel.

153,181.—Composition for Safety blazing Fuses.—G. C. J. Schneider, Erie, Pa.

153,251.—Treating Cotton-seed Oil for Paint.—H. Goldman, New York, N. Y. Aqua regia, bisulphide of carbon, and sulphate of baryta.

153,253.—Concretes for Paving and Roofing Tiles.—T. Heep, St. Louis, Mo.

July 28th.

153,451 —Surface Compound for Igniting Safety Matches —L. O. P. Meyer. India-rubber, sulphur, and sulphide of antimony.

153,473.—Coating Fabrics to imitate Leather, Morocco, etc.—A. Bell, New York, N. Y. Glue, glycerin, chromic acid, and tannic acid or Aleppo galls.

153,536 —Preparation of Coloring Matters from Anthracene.—H. Caro, Mannheim, Baden, and C. Graefe, and C. Liebermann, Berlin, Prussia.

153,573.—Treating Copper Ores.—J. W. Kidwell, Georgetown, D. C.

153,636 —Tanning Processes.—C. J. Tinnerholm, Quincy, Ill. Liming Compound: Lime, chloride of ammonia, sulphuric acid, and salts of tin. Batting compound: Bone flour, muriatic acid, and salts of tin. Tanning compound: Terra Japonica, sumach, and salts of tin. Whitening compound: Flowers of sulphur, nitric acid, spiritus minderer, etc.

August 4th.

153,680.—Cements for rendering Leather Waterproof —A. McNicol, Ypsalanti, Mich. India rubber, gutta-percha, and balata, dissolved in chloroform.

153,698.—Manufacture of Iron resembling Spiegeleisen.—Ed. Baker, Milstone, N. J.

153,707.—Process for treating Sponge for Upholstering Purposes.—P. S. Devlan, New York, N. Y.

153,727.—Purifying Illuminating and other Gases.—B. Silliman, New Haven, Conn. Salt cake, alkaline bisulphates, or other acid salts to remove ammonia and its compounds, etc.

153,732.—Processes for producing Vitrified Photo-enamels.—W. T. Watson, Hull, Eng

153,743.—Refining Copper.—J. R. Cooper, Hancock, Mich.

BOOKS RECEIVED.

Neues Handwörterbuch der Chemie. Auf Grundlage des von Liebig, Poggendorff und Wöhler, Kolbe und Fehling herausgegebenen Handwörterbuchs der reinen und angewandten Chemie und unter Mitwirkung von Bunsen, Fittig, Fresenius, v. Gorup-Besanez, Hofmann, Kekulé, Kolbe, Kopp, Wichelhaus u. s. Gelehrten bearbeitet und redigirt von Dr. Hermann v. Fehling, Professor der chemie in Stuttgart.

Caspari, O.—Die Thompson'sche Hypothese v. d. endlichen Temperaturausgleichung im Weltall, beleuchtet v. philosophischen Gesichtspunkt. Stuttg

Méne, Ch.—Guide pratique pour l'analyse chimique des engrains. 12.

Mohr, F.—Chemische Toxicologie. Braunschw.

Bulletin of the Bussey Institution of Harvard University. Part III 1874. 8vo. 100 pp.

This valuable contribution to agricultural chemistry contains papers by Prof. F. H. Storer, on the Valuation of the Soluble Phosphoric Acid in Superphosphate of Lime; on the Average Amounts of Potash and Phosphoric Acid contained in Wood Ashes from Household Fires; and on the Importance as Plant Food of Nitrogen in Vegetable Mould.

"Viaje a la Caverna de Cacahuamilpa datos para la geologia y la flora de los estados de Morelas y Guenero" "por Mariano Barcena alumino de la escuela especial de ingeneros de Mexico." Mexico: Government Printing Office. 1874. Pamphlet, 28 pp.

This pamplet contains principally interesting geological notes on the formations exposed in the cave of Cacahuamilpa, and also the geology of the country between this cave and the city of Mexico The cavern is peculiar as being apparently a sort of subterranean cañon in which the strata on either side are well exposed, and afford facilities for examination. The notes here recorded are interesting as giving some information on a subject as yet but little known, viz., the geological structure of Mexico.

"Jahresbericht über die Untersuchungen und Fortschritte auf der Gesammtgebiete der zucker fabrikation von Dr. K Stammer." Jahrgang XII Brunswick, 1873. 8vo. 375 pp.

The most striking part of this yearly volume is the excellent arrangement of the abstracts from the various articles which have been published on subjects in any way connected with the manufacture of sugar. The heads are Statistical, Agricultural, Mechanical, Technical, and Literary. Among the abstracts especially to be noted are those referring to the solubility of sugar in aqueous alcohol, by Dr. Scheibler; some on the use of the Fehling's solution, by Brunner; and those by Grandeau and Steiffer on the extraction of rubidium from the residues of the manufacture of spirit from beet-sugar molasses As a work of reference for any one interested in the manufacture of sugar this annual review is most valuable.

"Die Geologische Landesmetersuchung des Konigreichen sachsen." Dr. H. Credner Pamphlet, 8vo 10 pp.

Vorschläge zu einer neuen Classification der Gesteine, von Prof. Dr. H. Credner in Leipzig. Pamphlet, 8vo. 12 pp.

"L'Année Scientifique et Industrielle ou exposé annuelle des travaux scientifiques, des inventions et des principales applications de la science à l'Industrie et aux arts, qui ont attire l'attention publique en France et a l'etranger, accompagné d'une Nécrologie scientifique" Louis Farquier. Dix-septième Année (1873). Paris Librarie Hachette et Cie. 1874. 8vo. 579 pp.

So much is constantly being added to our information on scientific subjects that such reviews of annual progress as the one before us, have become almost a necessity for any one desirous of keeping himself informed as to what has been and is being done in the scientific world. Since the sources from which such information is to be derived are so numerous, perhaps none of these reviews are absolutely complete. This volume, however, in aiming at that end, affords a convenient and valuable book of reference on scientific subjects. The novelties in Astronomy, Physics, Mechanics, Meteorology, Chemistry, Natural History, Constructive Engineering, Hygiene, Medicine and Physiology, Agriculture, and Industrial Arts are here briefly described in the attractive style of which the well-known author of the work is master.

The Birth of Chemistry, by G. F. Rodwell, F.R.A.S., F.C.S. London: Macmillan & Co., 1874.

The chapters in this neat little volume, relating to the Early History of Chemistry, first appeared in *Nature*. Notwithstanding Mr. Rodwell's too-evident attempts at fine writing and chemical eloquence, if we may be allowed the expression, we have here a most interesting contribution to the history of chemical science, popular in style, and at the same time evincing considerable originality of study and some research

Mr. Rodwell treats in order the primitive theories respecting the history of matter, the metallurgical chemistry of the ancients, alchemy, early ideas respecting the nature of combustion, and the rise of pneumatic chemistry.

Mr. Rodwell gives a very interesting account of Hooke's, Mayow's, and Hale's experiments, and shows how they paved the way for the discoveries of Priestley, the centenary of whose discovery of oxygen has been recently celebrated on both sides of the water, at Birmingham and at Northumberland.

The illustrations, with which the work abounds, increase its usefulness and add to its value We find fac-similes of ancient alchemical MSS.; reproductions of designs of alchemical processes from the rare and famous folios of Mangetus; illustrations of early Egyptian skill, and many other engravings, including a portrait of John Mayow, who so narrowly escaped discovering oxygen.

The following extracts will give the reader some idea of the author's style:—

"What manner of men were the alchemists? How did they preserve, cultivate, and transmit the wonderful delusions of their creed? We have endeavored in a former chapter to show that the idea of transmutation arose from the old Greek idea of the conversion of one element into another; and the belief in the possibility of transmutation once admitted, the pursuit of the alchemist would naturally follow in a mystical and credulous age. As to the men themselves their character was twofold; for there was your alchemist proper, your true enthusiast, your ardent, persevering worker, who believed, heart and soul, that gold could be made, and that, by long search or close study of the works of his predecessors, he could find the Philosopher's stone; and there was your knavish alchemist, a man who had wits enough to perceive that the search was futile, and impudence enough to dupe more credulous people than himself and wheedle their fortunes out of them on pretence of returning it tenfold in the shape of a recipe for converting lead into gold . . . . . Of the true alchemist we have many pictures. The alchemist, the astrologer, the mystic, the wizard, were men of the same stamp. They often practised the same arts side by side. The same habit and altitude of thought belonged to one and to all, and became all equally well. Take the dreamy, maudlin, semi-maniacal Althotas, who has been described so well by Dumas 'An old man, with gray eyes, a hooked nose, and trembling but busy hands. He was half buried in a great chair, and turned with his right hand the leaves of a parchment manuscript.' Note also his intense abstraction his forgetfulness of the hour, the day, the year, the age, the country; his absolute and intense selfishness and absorption, the concentration of the whole powers of his soul upon his one object.

Or let us look at Victor Hugo's Archidiacre de St. Josas, in his search for the unseen, the unknown, and the altogether uncanny; the bitterness of his soul, his passionate musings, his conjurations and invocations in an unknown tongue; his own self, that wonderful mixture of theologian, scholar, mystic, perhaps not much unlike the divine S. Thomas Aquinas himself.

"If we peep into Dom Claude's cell, we are introduced to a typical alchemist's laboratory—a gloomy, dimly-lighted place, full of strange vessels and furnaces and melting pots; spheres and portions of skeletons hanging from the ceiling; the floor littered with stone bottles, pans, charcoal, aludels and alembics, great parchment books covered with hieroglyphics; the bellows with its motto—'Spira, Spera;' the hour-glass, the astrolabe, and over all cobwebs and dust and ashes."

Mouth of the Mississippi-Jetty System Explained. By James B. Eads. Pamphlet, 8vo., 40 pp. St. Louis, Mo., 1874.

Fifth Annual Report of the Geological Survey of Indiana. By E. T. Cox, State Geologist. 8vo., 494 pp. Indianapolis, Indiana, 1874.

The Iron Works of the United States. Prepared by the American Iron and Steel Association. Pamphlet, 8vo., 106 pp. Philadelphia, Pa., 1874.

Address of Ex-President Joseph Lovering before the American Association for the Advancement of Science, at Hartford, August 14, 1874. Pamphlet, 8vo., 36 pp. Salem, Mass., 1874.

Contributions from the Laboratory of the University of Pennsylvania. No. II. On an Improvement of the Burette Valve. By George A. Koenig, Ph.D. Read before the American Philosophical Society, August 21, 1874. Pamphlet, 8vo., 6 pp.

Shadows from the Walls of Death. Facts and Inferences prefacing a Book of Specimens of Arsenical Wall Papers. By R. C. Kedzie. Pamphlet, 8vo., 8 pp. Lansing, Mich., 1874.

Advanced Education. By Andrew D. White. Pamphlet, 8vo., 20 pp. Boston, 1874.

Contributions from the Laboratory of the University of Pennsylvania. No. III. On American Tellurium and Bismuth Minerals. By F. A. Genth. Read before the American Philosophical Society, August 21, 1874. Pamphlet, 8vo., 9 pp.

Report of the Commissioners of Agriculture for the Year 1872. 8vo., 524 pp. Washington, D. C., 1874.

Jahresbericht über die Forschritte auf dom Gebiete der Reinen Chemie. Von Dr. Wilh. Staedel. Erster Jahrgang für 1873. Pamphlet, 8vo., 557 pp. Tübigen, 1874.

Handbuch der Technischen Chemie. Nach A. Payen's Chimie Industrielle frei bearbeitet. Von F. Stohmann und Carl Engler, II. Band. Organische Chemie. Pamphlet, 8vo., 876 pp. Stuttgart, 1874.

The Lyceum of Natural History in the city of New York, is one of the oldest scientific societies in the United States, having been organized in the year 1818, and having maintained its meetings regularly since that time.

Although the name so long identified with the history of the Lyceum, might seem to limit its discussions to biological subjects, yet all departments of chemical and physical investigation are freely and largely presented at its meetings.

For over half a century, the Society has published its principal materials in the well-known "Annals of the New York Lyceum." Herein appear all the more detailed and extensive papers presented at its meetings. In addition to these, the *Proceedings* are now issued, which are intended to contain all abstracts and briefer communications, and to present an actual record of the operations of the Society.

The rate of subscription for the *Proceedings* is fixed at one dollar per year. It will be the efforts of those charged with the publication of the *Proceedings*, to present in every number some positively new material in various departments of research.

Subscriptions should be addressed to Mr. Robert Dinwiddie, Corresponding Secretary, No. 113 Water Street, New York.

BREVITIES.

Acetic Acid in Wines.—M. Kissel states that in separating acetic acid from wines by distillation, the acid may escape undetected, because it forms acetic ether with the alcohol. This inconvenience may be avoided by saturating the wine with baryta. The alcohol is then distilled off, and phosphoric acid added to the residue. On distilling again, the acetic acid is found in the distillate, and may be determined.

The Use of Sulphide of Sodium in Tanneries.—One of the earliest processes in the preparation of hides for tanning is the removal of the hair. This is sometimes effected by inducing a slight putrefaction, which loosens the epidermis and renders the hairs easily detachable. But in this country the method usually adopted is to place the hides in a large vat or pit containing milk of lime, in which they are frequently moved so as to allow the lime to act equally on every part. After from sixteen to twenty days the hair is easily removed by a blunt scraper.

In Germany, Austria, and Belgium, however, the trade is reported to have all but abandoned the old methods of unhairing, in favor of one in which sulphide of sodium is the depilatory agent; the sulphide of sodium in a crystalline form being now especially manufactured for the purpose in Germany. The process is modified in various ways to meet the peculiarities of the material operated upon. Sometimes, where it is necessary that the hair should be removed as quickly as possible, as in the case of sole leather, the hides are painted with a paste consisting of one part of crystallized sulphide of sodium and three parts of lime. The hides are covered with damp matting to prevent the drying of the paste, and in fifteen or twenty hours the process is complete, and the hides can be unhaired. In other cases the skins are steeped in a solution of sulphide of sodium (1 lb. to 100 quarts), when the time required is two or three days. Where the hides are to be unhaired by hand, it is necessary that they should be first well rinsed with water; and the men employed in the laying on the paste are usually provided with India-rubber gloves, on account of its corrosive properties.—*Pharmaceutical Journal.*

Dr. Edwin Lankester.—The London *Daily News* of Oct. 31, in announcing the death of this distinguished medical writer, says: "Dr. Edwin Lankester, M.D, LL.D., F.R.S., was born at Melton, in Suffolk, April 23, 1814, and was, consequently, in his sixty-first year. He was educated at Woodbridge, where he was apprenticed to a surgeon; from 1834 to 1837 he studied medicine at University College, London, and in 1838 he was made a member of the College of Surgeons and licentiate of the Apothecaries' Society. In 1839, according to a contemporary record, he visited the Continent, and graduated at Heidelberg; in 1843 became lecturer on Materia Medica and Botany at the St. George's School of Medicine; in 1844 Secretary to the Ray Society, and in 1845 was elected Fellow of the Royal Society. In 1850 he was appointed Professor of Natural History, New College, London; in 1851 received the degree of LL.D. from Amherst, United States; in 1853 became lecturer on Anatomy and Physiology at Grosvenor-place School of Medicine; in 1858 Superintendent of the Food Collections at the South Kensington Museum; in 1859 President of the Microscopical Society; in 1862 Examiner in Botany to the Science and Art Department at South Kensington; and was elected Coroner for Central Middlesex in 1862. Dr. Lankester contributed to the *Naturalist*, *Annals of Natural History*, to the *Pharmaceutical Journal*, the *Penny Cyclopædia*, and *Reports of the British Association for Advancement of Science*. He wrote *Natural History of Plants Yielding Food*, and *Memorials of John Ray*, published in 1845; edited the *Correspondence of John Ray* in 1846; contributed the article "Rotifera" to the *Cyclopædia of Anatomy and Physiology*, and a "Report on the Progress of Organic Chemistry" to the *Companion to the British Almanac*, in 1847; and published a translation of Schleiden's *Principles of Scientific Botany*, in 1849. Dr. Lankester, who contributed reviews of medical works and papers on natural history to the *Athenæum*, became joint editor of the *Quarterly Journal of Microscopical Science*, in 1853; has written "Botany" in Hughes' *Reading Lessons*, and by the command of her Majesty edited the *Natural History of Dee-side*. He translated Küchenmeister's *Animal Parasites*, in 1859; contributed, in conjunction with Dr. Lethby, the article on Sanitary Science to the *Encyclopædia Britannica*, in 1859; published *Half-hours with the Microscope; Two Addresses to the Microscopical Society of London; A Guide to the Food Collection at South Kensington Museum; A Course of Lectures on Food;* and *A Course of Lectures on the Uses of Animals*, and delivered lectures on natural history, and its various branches, at the Royal Institution; several courses on physiology and botany at the London Institution; and several courses on botany before the Royal Botanical Society of London. As coroner for Middlesex he published seven annual reports in the proceedings of the Social Science Association; and as Medical Officer of Health for St. James', Westminster, published fourteen annual reports. In 1866 he edited the *Journal of Social Science*, and published a small work entitled *Cholera: What it is and How to Prevent it.* In 1867 appeared *Good Food; What it is and How to Get it;* in 1868, *Vegetable Physiology;* in 1869, *a School Manual of Health;* and in 1870, *What shall we Teach, or Physiology in Schools;* besides several articles in *Nature* on scientific subjects.

Rev. Dr. Thomas R. Pynchon, a graduate of Trinity College and late Professor of Chemistry and Natural Science and tutor in the classics, has been elected President of that Institution in place of Dr. Jackson, lately deceased.

J. M. Merrick, B.Sc., has been unanimously elected Professor of Chemistry in the Massachusetts College of Pharmacy. Mr. Merrick is a graduate of the Lawrence Scientific School, and this institution is fortunate to secure his services in this important department of science.

Dr. Jeffries Wyman, Hersey Professor of Anatomy in Harvard University, died September 4th, sixty years of age. The chair thus rendered vacant has been tendered to Dr. Joseph Leidy of Philadelphia.

The Chemical and Natural History Society of the Lehigh University has dispatched its curator, Robert G. Bechdolt, to the West Indies and Brazil to collect specimens in natural history for the Museum of the Society. He will be absent about five months. Mr. Bechdolt's specialty is botany, but he will not confine his attention to this department.

S. M. Pitman, after five years' study abroad, becomes Professor Marshall's assistant in chemistry, Tufts College, in Massachusetts.

The Khivan expedition is said to have brought into notice a rival to the famous Prussian *erbswurst*, or pea-sausage. The Russian soldiers were fed chiefly on biscuits composed one-third of flour of rye, one-third of beef reduced to powder, and one third of sauerkraut, also reduced to powder. The soldiers had a great relish for this food, and their good health during the expedition is attributed in great part to the use of it.

THE AMERICAN CHEMIST.
Vol. V. No. 7.

DETERMINATION OF PHOSPHORUS.

BY T. T. MORRELL.

Persons not accustomed to the use of Nessler's ammonia test may be glad to have pointed out its application to the estimation of minute quantities of certain precipitates containing an invariable amount of this substance.

An instance of this application is the determination of the yellow precipitate produced by molybdate of ammonia in solutions containing tribasic phosphoric acid. The precipitate should be thrown on a filter which has been freed from iron, washed with dilute molybdenum solution, and then with distilled water containing one per cent. of nitric acid. It should now be dissolved into a test-tube by a small measured quantity of dilute potash solution, the liquid diluted to a standard amount, and a measured quantity of Nessler's solution added.

If, as some assert, the ammonia in this precipitate is always in a definite ratio to the phosphoric acid, by using half a gramme of the substance, the test may be used for as high as fifteen per cent. of phosphorus.

It might be added, that, taking advantage of the molybdic acid it contains, the amount of phosphorus in very small quantities of this precipitate might be quite accurately arrived at, from the highly colored salts of molybdenum. For this purpose, the molybdates of molybdenum are the best, and especially the green molybdate, but this method is less convenient.

Cambria Iron Works, Johnstown, Pa.

ON THE ATOMICITY OF THE CERITE AND GADOLINITE METALS.

BY PROF. M. DELAFONTAINE.

Mr. P. T. Cleve, of Stockholm, has published lately (*Bulletin de la Société Chimique de Paris*, xxi. Nos. 5, 6, 8) a series of very important papers on the compounds of lanthanum, didymium, erbium, and yttrium, in which he regards these metals as tri-atomic, and therefore he assigns to their oxides the general symbol R_2O_3, instead of RO as generally admitted.

The reasons which have led Mr. Cleve to propose that change are chiefly because the symbol of several double salts is thus made plainer, and, also, the water of crystallization of many of the compounds of these rare metals is represented by whole numbers of molecules instead of fractional ones.

These considerations have a certain weight, indeed, although we have numerous proofs of the fact, that the simplicity of a symbol is by no means an absolute criterion of its accuracy.

I must confess, for my own part, that they do not suffice to carry conviction. There are quite a number of facts which seem to me to militate in favor of the generally adopted opinion, that the metals extracted from the cerite and the gadolinite are diatomic; they at least make it desirable that better proofs should be brought forth against it.

Crystallography, which has thrown so much light on the constitution of a great many compounds, is of little help in the present case. It gives, however, a few facts which speak rather in favor of the diatomicity of the metals under consideration. Thus, for instance, the cadmic sulphate which crystallizes with $\frac{1}{2}$ Aq is regarded by several chemists as isomorphous with the didymic, yttric, etc., sulphates. The bromates of cerium, lanthanum, and didymium (RBr_2O_6+6Aq, hexagonal) bear to the tesseral bromates of the magnesian series that same relation which M. Marignac has pointed out several times in compounds which have evidently the same constitution.

Although less convincing, perhaps, the chemical considerations are also against the hypothesis of the triatomicity of the gadolinite metals. The oxides of these metals rank among the most powerful bases, after the alkalies. They combine directly with water, and their hydrates absorb carbonic acid from the air. Their union with the several acids is accompanied with an energetic production of heat. They expel ammonia from its salts. Their own compounds crystallize readily, and the acid that they contain seems to be fully neutralized. Truly, the erbic and yttric sulphates being subjected to a strong calcination lose two-thirds of their sulphuric acid, but that mode of decomposition does not seem to apply to the other salts, to the nitrates, for example. Whilst the sesquioxides, like alumina, iron, and chromic oxides, have no or little affinity for carbonic acid, the earths, of which we speak in the present article, form normal crystalline carbonates. A strong calcination makes the ordinary sesquioxides insoluble, or nearly so, in the acids; the same operation has little or no effect upon yttria, erbia, and the like. The insolubility of the fluorides is no argument, since aluminic fluoride is insoluble just as well as calcic or barytic fluoride.

The foregoing considerations, to which several others could be added, show, that, if the cerous, yttric, etc., oxides are sesquioxides, they bear the most striking resemblance to the protoxides of the metals of the magnesian series; and at the same time differ no less strikingly from alumina and the other sesquioxides. They make it desirable, as I said before, that new facts should be added to those which have prompted Mr. Cleve to propose his new symbols.

Chicago, No. 32 Walnut Street.

ON ERBIUM AND TERBIUM.

BY PROF. MARC DELAFONTAINE.

(*Communicated to the Chicago Academy of Sciences meeting of May*, 1874.)

In 1788 Captain Arrhenius discovered, in the quarries of Ytterby, a black mineral, whose analysis was made by Gadolin, six years later, and in which he discovered

a new earth. Ekeberg named the mineral *Gadolinite* and the earth *yttria*. The latter, however, was not an homogeneous substance, for Ekeberg extracted some *glucina* from it in 1802, Berzelius some *ceria* in 1815, Mosander some *lanthania* and *didymia* in 1830, and finally some *erbia* and *terbia* in 1843. The second, third, and fourth of these bodies are more abundantly found in the cerit from Bastnæs. The results of Mosander's experiments were confirmed by Scheerer and Berzelius. In 1864, Popp* denied the existence of both erbia and terbia, whilst at the same time I was led to adopt the views of Mosander. More recently, Bunsen and Bahr† denied also the existence of terbia, and applied the name of *erbia* to a base, the characteristics of which are quite different from those assigned by Mosander to the base discovered by him.

(Bunsen's and Bahr's erbia is rosy, its atomic weight is 112·6; hydrogen has no action on it. The earth described under the same name by Mosander is deep yellow; heated in a current of hydrogen it turns white.)

In a paper of which I know unfortunately but a short abstract published in this country,‡ MM. Cleve and Hœgland concur in the views of the German chemist. Already in 1866,§ I had made known the facts which prevent my accepting the conclusions of the savants opponents of Mosander. Ever since, multiplied experiments have confirmed my views. The material for my researches and also my notes having been entirely destroyed in the great Chicago fire, it is only a few months ago that I was enabled to buy a small supply of Gadolinite with which to start anew.

The following is a brief account of my new investigation :—

The mixture of yttria, erbia, and terbia, separated from the ceria, lanthania, and didymia by means of sulphate of potassa, was thrown into a glass containing acetic acid diluted with 250 to 300 times its volume of water; the quantity of acid used must be scarcely sufficient to saturate the bases. After eight or ten days, the weather being rather cold, nothing solid was left in the glass, and the liquid, although transparent, was quite opaline. Even after two weeks more, there was no change in the liquid, although, in former times, I noticed in several cases a kind of a settlement of the white mass in the lower part of the glass. The solution passes very slowly through a filter without becoming any clearer.

The addition of a small quantity of dilute ammonia increases a little the opalescence, or else it causes the formation of a precipitate which redissolves after agitation. If, then, the liquid be heated to the boiling point, a kind of a curding occurs; and, by filtering the hot liquid, one collects a jelly, which must be washed with boiling water. That jelly is pale lavender-colored while wet; it becomes darker by drying, and resembles then the hydrate of thoria—the color excepted. A calcination expels water and acetic acid from that substance, and leaves small pieces of a bright orange-yellow earth, which partakes of all the characteristics of the erbia which I obtained formerly when I followed the methods described by Mosander. I must say, however, that the production of oxygen under the action of the strong acids is much greater with the earth made by the new process.

A syrupy solution of the nitrate of that yellow base shows, under a thickness of 5½ centimetres, a *very weak* absorption spectrum mark of the principal lines of terbium (erbium of MM. Bunsen and Bahr). There is no trace of didymium.

Two samples of the earth dried at 400°, and rapidly weighed and heated in a current of hydrogen, have lost respectively 3 and 3·51% of their weight, and turned entirely white. The calcination of the oxalate gives a much paler base, which loses less hydrogen than that prepared from the subacetate. I believe that in neither case the reduction was as complete as it could be, for the residue, being thrown into sulphuric acid diluted with its own volume or two of water, would combine with a great evolution of heat and production of bubbles. The concentrated acids dissolve readily the earth from the subacetate, oxygen is expelled, and the mass is entirely deprived of any yellowish, brownish, or reddish color. The combination occurs much more slowly when acids diluted with 5 or 6 volumes of water are used. It is exceedingly slow with cold nitric acid in 40 volumes of water; heat helps it somewhat with a gentle disengagement of very small bubbles. The last dissolved parts present exactly the same appearance as the first ones.

1·812 grm. of dried sulphate, being precipitated by means of oxalate of ammonia, and the precipitate strongly heated, has given 0·983 of base, which leads to the atomic weight 95.

Another sample of earth, treated twice by dilute acetic acid, and converted into sulphate, has given for the latter—

Salt, 2·696 grms.; base 1·110; water 0·6021 (22·33%) leading to the atomic weight 90·2.

2·573 grms. of sulphate from another preparation, lost 0·576, 22·46% of water.

Finally all the material used for the above-described experiments was dissolved in a large excess of nitric acid, and subjected to a series of fractional precipitation by means of oxalic acid. The four oxalates thus obtained gave a quantity of base varying from 39·21% (first precip.) to 38·81% (last precip.). The atomic weights calculated therefrom, range from 92·87 (max.) to 91·33 (minimum).

Although the earth which makes the subject of the present note was not strictly pure, it seems to me impossible to regard it either as a mixture of the rosy earth and yttria, or of the latter with cerium oxide.

Were the first supposition true, from the atomic

* *Popp*, Untersuch. über Yttererde; Annales des Chemie und Pharmacie, cxxxi. 179.

† *Bahr und Bunsen*, Ueber Erbinerde und Yttererde; Annalen der Chem. und Pharm., cxxxvii. 1.

‡ Silliman's American Journ., v. p. 133 (Feb. 1873).

§ Archives des Sciences physiques et naturelles. Geneva, t. xxv. 105. (Feb. 1866.)

weight (92 about), one would have to admit the presence of one-third of rosy earth to two-thirds of yttria; as I said before, my product exhibits so weak an absorption spectrum that such a supposition is inadmissible. I fail also to see how a dirty-rosy earth mixed up with a very nearly white one could give the deep yellow color above alluded to. Furthermore, the chemists who have worked on that subject agree upon the fact that both the rosy base and yttria remain unchanged in hydrogen.*

One will notice, also, that the atomic weight resulting from my last experiment (92 for the base, and 76 for its radical) as quite near to that (95·3) which I obtained ten years ago for an earth prepared from materials and with methods quite different.

As for the presence of cerium, it is still less admissible. I conclude to publish the results of my latest investigation, however imperfect, in the hope that the chemists who have ampler means than I have, will give the question a renewed attention, and show, if the case may be, what a source of error I have failed to avoid.

If the reader will take the trouble of referring to the memoir of Mosander, or to Berzelius' Treatise on Chemistry, he will see that the earth described in the present paper is the true *erbia*, and he will conclude also, I think, that the rosy base described by Bunsen and by Cleve, under the name of erbia, is very probably the terbia of Mosander. However, in order to prevent any confusion, it would perhaps be better to give the yellow earth a new name, that of Gadolinia or Mosandia.

Woman's Medical College, Chicago,
May 1, 1874.

DETERMINATION OF DISSOLVED OXYGEN IN WATER.

COMMUNICATION FROM H. ENDEMANN, PH.D.

To the Editors of the American Chemist:—

Gentlemen: At the meeting of the Lyceum of Natural History, at which Prof. Wurtz explained to the members his method for the determination of oxygen by means of pyrogallic acid, he expressed himself to the effect that he felt somewhat grieved that nobody had as yet adopted his method, though it had been published some time ago (Sept. 1873), while the hydrosulphurous method had already won many friends. Yet he claims now in his reply (July No.), that his method then (March, 1874) was far from being perfect, and that I was premature in criticizing it in a printed communication. I beg to say that I considered, and still consider, a communication to the members of a scientific body in public session as equivalent to a publication, and consequently felt fully justified in writing the critical remarks which appeared in the July number of the *American Chemist*, all the more so, as I was induced by Prof. Wurtz's communication to the lyceum to apply his method—unsuccessfully.

This I write solely to defend myself against the imputation of having rushed into print against Prof. Wurtz in a premature and unwarranted manner.

Prof. Wurtz, in his defence, instead of bringing his method before the public, strives rather to discredit my observations, by misleading your readers as to the contents of his paper read before the lyceum. Speaking of the expulsion of oxygen from water by carbonic acid, he takes the point, that I deny this well-known fact altogether, while I only meant to criticize the manner in which he tried to verify it before an audience at the meeting referred to.

Prof. Wurtz (for the sake of your readers, and for better understanding, I ought to have described his method more thoroughly) took an aerated water, added carbonate of soda in solution, and then diluted sulphuric acid. Carbonic acid develops rapidly, and while bubbles of carbonic acid are still being evolved he adds his pyrogallic solution.

This being the shorter method, he recommended it especially, stating that the expulsion of oxygen was almost instantaneous.

In his reply he does not speak of this instantaneous expulsion, but tries to persuade your readers that his method of operating was far more thorough, allowing the carbonic acid to pass through the water for three minutes. This method of proceeding on the part of Prof. Wurtz induces me to refrain from any further discussion regarding the value of his discoveries, until they are in print before the public.

Allow me to state, also, that I have not used Prof. Wurtz's test for my investigations, but merely a reaction applied by me for about sixteen years, and by many older chemists, very likely, much longer; for Wurtz's test is merely the application of pyrogallic acid for *quantitative* determinations (color test), and a reliable method for doing this, as he now states himself, does not exist yet.

As for the rest, I shall be happy to do justice to Prof. Wurtz's method, whenever he shall place it before the public in the perfected form promised.

NEW PRODUCTION OF FAST BLUE BY MEANS OF HYDROSULPHITES.

BY M. GROS RENAUD.

Translated for the American Chemist from Le Moniteur de la Teinture, Vol. 17, Nos. 12 and 13, by Chas. A. Pitkin, B.A.

Schutzenberger and Laland Processes.

The principle on which depends the process I am called to describe at this time is based, like all other processes for a fast blue, on the property which indigo-blue possesses, though itself insoluble, of being brought by reducing agents into the condition of white indigo soluble in the alkalies and alkaline earths. This result having been obtained, it then only remains to add to the white indigo a sufficient quantity of a reducing agent, with the proper amount of the solvent to pre-

* Truly Bahr and Bunsen say that yttria is yellowish, but the atomic weight they assign to it is 77·70, whilst Mr. Cleve finds it = 76·4 and I = 74·5. My yttria was almost white.

vent the oxidation of the white indigo during the handling and printing of the color. It is true that, considering the strong affinity that white indigo possesses for the oxygen of the air, the process in question, like all similar ones, presents in putting it in practice serious difficulties, difficulties nevertheless which we ought not to exaggerate. We should not condemn a process on account of failure at first. We have only to recall the introduction of aniline-black into our print-works. It is thoroughly understood by every one who has followed closely the progress of this unrivalled color, that the good results obtained have been the fruit of painful labor. At this very time, we are having an experience not less serious with the admirable products of anthracene. Do we think of abandoning those rich colors which will be called on sooner or later to replace the alizarine of the madder-root? Ought we then, after experiencing a few drawbacks and difficulties, to give up a process which presents indisputable advantages, both as regards execution and promptness of action? I should not advise such a course, being thoroughly impressed as I am with the difficulty that all manufactures give in being introduced, and as we may say, acclimated, in our print works. We have only to consider, in fact: 1*st*. The method of preparing the acid or neutral hydrosulphite. 2*d*. The physical condition in which white indigo exists. 3*d*. The nature of the thickening agents. 4*th*. The solvent of the white indigo. 5*th*. The method of compounding the colors. 6*th*. The relative proportions of the different substances which enter into the color. 7*th*. The temperature, which has an important influence on the final result of the process in question.

It follows then that we can take up the matter under the following heads:—

1*st*. Manufacture of acid hydrosulphite.
2*d*. Manufacture of neutral hydrosulphite.
3*d*. Reduction of blue indigo to white.
4*th*. Production and printing of the different colors—
A Direct colors.
B Thick "
C Thin "
5*th*. Testing of the bisulphite and the soda.
6*th*. Operations necessary for the pieces to be subjected to after the printing.
7*th*. Recovery of the indigo from the residue of the colors.

We shall treat the subject then under these heads, and try to be as concise as possible, so as not to abuse the patience of our readers, considering the extent of the question to be considered.

Preparation of the Acid Hydrosulphite of Soda.

We shall not enter into theoretical considerations. We shall only say that hydrosulphurous acid is a new acid discovered by M. Schutzenberger, and may be considered as sulphurous acid to which two atoms of hydrogen have been added. The formula of this acid, according to the interpretation of its discoverer, is (SOH) + HO. The facility with which this acid decomposes must necessarily involve some change in any body with which it is placed in contact. Considering therefore its instability, and its great affinity for the oxygen of the air, the preparation of a salt by means of hydrosulphurous acid demands certain precautions which we will take up in order. To make the acid hydrosulphite of soda, we take any vessel which can be hermetically sealed. Its size, of course, depends on the quantity of hydrosulphite we wish to prepare for immediate use. The vessels are filled with strips of zinc, which are rolled up, and bisulphite of soda at 32° B. containing a strong excess of sulphurous acid is poured on, taking care to fill the vessels completely. The zinc and the bisulphite are then allowed to react on each other for an hour, at least, being turned about two or three times, if the vessels allow. At the end of this time the acid hydrosulphite is formed, and gives its greatest yield. It indicates 35° B. Thus prepared, this acid hydrosulphite must at once be used either to reduce blue indigo or make neutral hydrosulphite, or any of the other processes for which we have to resort to the acid hydrosulphite. In preparing acid hydrosulphite of soda, we may replace zinc in plates by the same metal granulated or in the state of powder. The first of these varieties is difficult to clean, and the second presents such irregularity in its chemical composition, that we have completely renounced its use. Moreover, its fine subdivision heats the mass so much, that there is reason to fear the decomposition of the hydrosulphurous acid. It is well known that the further mechanical subdivision of bodies is carried, the more energetic are the chemical reactions which take place between them, when placed in contact with each other. As soon as the operation is finished it is necessary to wash with ordinary water to remove the salts of soda and zinc, and then to fill the flask with water to prevent useless oxidation of the zinc.

Now for another operation, all that is necessary is to pour off the water, clean the zinc by means of water acidified with hydrochloric acid, and then rinse it. As the quantity of zinc diminishes, it is necessary to add more, so as to keep the vessels always full. We should not lose sight of the fact that 30 to 35 grammes are dissolved for every kilogramme of bisulphite used, without including the zinc lost in the cleaning. No systematic results can be expected unless the acid hydrosulphite of soda is used immediately after being made.

Preparation of the Neutral Sodic Hydrosulphite.

The quantity of lime or alkali required to neutralize the acid sodic hydrosulphite once being known, it is easy to make the neutral hydrosulphite. Here we work still out of contact with the air. We weigh in stoppered vessels 350 grammes of milk of lime, in proportion of 200 grammes of quicklime to the litre, then 1 kilogramme of acid hydrosulphite. After the mixture is made it is well shaken. If the temperature should rise too high, it would be well to cool the vessels in which the decomposition is taking place. The saturated hydrosulphite can be kept for quite a while; thus I prepare what I want the day before. I have even succeeded with hydrosulphite two days old. If it has an alkaline reaction, it will keep without trouble. When we are ready to use the neutral hydrosulphite, we take the whole mass in the vessels in which the decomposition has taken place, pour upon a cloth or into sacks according to the scale we are working on, and submit it to the action of a strong press. The liquid which runs out represents, very nearly, the weight of the acid hydrosulphite employed, and indicates 23° B, when the bisulphite used is 32°, and the acid hydrosulphite 35° B.

If there should remain on the filter a considerable quantity of neutral hydrosulphite, it would only be necessary, in order to keep it for some time, to add a little milk of lime to make it alkaline. In this preparation we have not found it advantageous to replace lime by caustic soda, although the latter gives a far more voluminous precipitate than the former.

Reduction of the Indigo.

Setting of the Vats.—In an indigo mill we grind in the ordinary manner, with water, two kilogrammes of good Bengal indigo, and so arrange it that the volume of the liquid, including the indigo, shall be 20 litres. We place this portion of 20 litres of indigo ground in water in a boiler of 60 to 80 litres capacity, and then add from 5 to 5¼ kilogrammes of caustic soda at 36° B., and 14 kilogrammes of acid sodic hydrosulphite. We heat the solution to about 72° to 75° C., and keep it at that temperature for 15 or 20 minutes.* Then by means of a funnel, with a long neck, reaching to the bottom of the boiler, and constantly in motion, we pour in from 3½ to 3¾ litres of hydrochloric acid. This must be done under a chimney with a strong draft, or else in the open air, on account of the immense quantities of sulphurous acid liberated during the operation. When the decomposition is complete, shown by the slight acidity of the liquid, the whole is transferred as quickly as possible into a vat holding about 150 or 160 litres, which is filled with ordinary water. The next day we draw off the liquid, on which floats the precipitate, by means of an outlet made at about 250 millimetres from the bottom. The vat is then again filled with water, to which neutral hydrosulphite has been added in the proportion of ¼ litre to 100 litres of common water. I should add, this last precaution is indispensable. On the third day they draw off again and place the precipitate thus washed on the filter. When it is all on the filter, and has been made firm by complete drainage, they obtain for 2 kilogrammes of dry indigo-blue about 7 kilogrammes of indigo, reduced to paste, which we call "dense precipitate." I shall not describe the methods of making the various other kinds of precipitates, since we have rejected them, giving the preference to this, which we have described under the name of "dense precipitate." Moreover, this last is amply sufficient for all requirements in the production of fast blues.

Production of Colors by Means of Reduced Indigo Precipitate.

All who have used indigo, as well as other coloring matters, know that the colors applied to the fabric are clearer and brighter, according as products of better quality are used. Thus recently a great English house, having neglected this principle, failed completely in the application of the process treated of in this article. Thus we see that the choice of indigo becomes a matter of serious importance for the manufacturer. The nature of the precipitate has an equally important influence on the product, and on the permanence of the color. Numerous attempts made to get the best conditions for making reduced indigo have resulted in our using exclusively the "dense precipitate," which I have described in detail in this article. We may add that the use of the "dense precipitate" is of more importance in that it is less subject than any other to oxidation by the air, it is more easily handled, and moreover it enables us to dispense with submitting the paste of reduced indigo to the press, an operation which is always troublesome. The concentration of 2 kilogrammes of indigo to 7 of paste is amply sufficient for the richest colors. To keep the indigo paste we have found it in every respect advantageous to put it in suspension in water thickened with gum. Thus we take 7 kilogrammes of the drained paste, and mix it with 20 kilogrammes of the thickened water, made in proportion of 1400 grammes of gum to a litre of water. Total, 27 kilogrammes of the gummy mixture, containing then 2 kilogrammes of blue indigo. This we call the "blue gum."

It is by no means safe, to succeed well with the color, to take indiscriminately the first thickening matter at hand.

After a number of trials, we have given the preference to gum Senegal, in spite of its coagulation by the alkalies and alkaline earths. Light dextrine may be used in certain cases, but the blue is not so fine, and when the color presents a small surface it looks rough. Starch, gum tragacanth, and roasted starch give very poor results, at least under the conditions with which we have worked.

Direct Colors.

Direct colors are those made without the intervention of the reduced indigo paste. They are made in the following manner:—

We place in a boiler

- 3¾ kil. indigo, ground in water, containing 2 kil. indigo-blue to a volume of 15 litres, heat and add
- 3 kil. powdered gum, after it is dissolved pour in
- 5 kil. "neutral" sodic hydrosulphite, then
- 450 grms. milk of lime (in proportion 200 grammes to the litre). Heat to 70° C. for 20 minutes, then allow to cool till 35° or 40°, and add
- 1½ kil. neutral hydrosulphite, and finally
- 450 grammes milk of lime. The result is—total—14 kil. coloring matter.

Colors by Reduced Indigo Precipitate.

Thick color with 40 grammes indigo-blue to the kilogramme of coloring matter.

- 20 kil. blue gum (7 kil. thick paste), 20 kil. gum and water in proportion of 1000 grammes to the litre.
- 6 kil. acid sodic hydrosulphite.
- 3½ kil. milk of lime (200 grammes to the litre), 1700 grammes to saturate the hydrosulphite, and 1800 grms. to dissolve the white indigo.
- 5½ kil. neutral sodic hydrosulphite.
- 2 kil. water, or water more or less thickened with gum.

Total.—36 kil. coloring matter, which is heated on a water-bath at 30° or 35° C.

Thin color with 40 grammes indigo-blue to the kilogramme of coloring matter.

- 20 kilogrammes blue gum as above.
- 10¾ kil. neutral sodic hydrosulphite.
- 1866 grms. milk of lime, in proportion of 200 grammes to a litre.
- 2 kil. of water, or gum and water.

Total.—36 kil. of coloring matter which is heated at 30° or 35° C.

Thin color with 30 grammes of blue-indigo to a kilogramme of coloring matter.

- 10 kil. blue gum.
- 6 kil. water more or less thickened with gum.
- 7 kil. neutral sodic hydrosulphite.
- 950 grms. milk of lime, in proportion of 200 grammes to the litre.

Total.—24 kil. of coloring matter which is heated at 30° to 35° C.

* This solution contains all the reduced indigo, and can be used at once in setting the vats for dyeing by diluting it more or less with water, according to the directions given in "Moniteur de la Teinture," vol. 17, No. 11, page 128.

Thin color by soda with 15 *grammes of blue-indigo to a kilogramme of coloring matter.*

4410 grammes blue gum.
8 kil. neutral sodic hydrosulphite.
6 kil. water, or ordinary gum and water.
420 grammes caustic soda at 36° B. as pure as possible.

Total.—20 kilogrammes of coloring matter, heated at 30° to 35° C.

Color by dextrine with 17 *grammes indigo to a kilogramme of coloring matter.*

1080 grammes of reduced indigo paste or dense precipitate without gum. Mix with
14 or 16 kil. dextrine solution (8 kil. light dextrine to 5 litres of boiling water).
5½ kil. neutral sodic hydrosulphite.
420 grammes soda at 36°, or milk of lime in equal amount.

Total.—17½ kil. of coloring matter, which is heated at 30° or 35° C.

We can, in the above blues, if we find it advantageous or convenient for special purposes, replace, without the slightest inconvenience, the milk of lime in proportion of 200 grammes of quicklime to the litre by the same weight of caustic soda at 36° B., as pure as possible, made from crystals of soda or else sal soda of the first quality. In the direct blues, and even in the others, it is always necessary to add a large excess of hydrosulphite, either acid or neutral, according to the kind of color one wishes to produce, for we must not lose sight of the fact that during the working of the color a considerable amount of hydrosulphite is converted into sodic bisulphite when the acid hydrosulphite is used, and into sodic sulphite when the color is formed with the neutral hydrosulphite. To counterbalance this oxidation produced by the constant presence of the air, and to keep the indigo reduced, the most convenient amount of neutral hydrosulphite to employ in this case is 350 grammes to the kilogramme of coloring matter containing 40 grammes of indigo-blue. Without the troublesome presence of the oxygen of the air 250 grammes of neutral hydrosulphite would be an abundance under these conditions. It is also very important, in the color in question, to allow for the disappearance of a certain quantity of lime; thus, to dissolve a quantity of precipitate corresponding to 40 grammes of indigo-blue, 33 grammes of milk of lime (200 grammes to the litre) ought to be sufficient, but we have been obliged to increase this proportion of calcic oxide to almost double, for it is necessary to raise it to 53 grammes in order to be able to count on a regular result in practice. This result on the large scale is wholly contradictory to that first obtained on a small scale, for it is well known that the calcic indigotate is more soluble than the bicalcic indigotate. With 33 grammes milk of lime we obtain the neutral salt, while with 53 the bibasic salt is formed. In this fact there is an anomaly which ought to be worked out. The illustrious Berzelius pointed out the existence of these two indigotates. Beyond 40 kil. of blue indigo to the kilogramme of coloring matter, it is not possible to deepen the colors. A blue of 50 grammes is not proportionally deeper, though it will be found advantageous to resort to a blue of this sort when it is desired to print delicate patterns, for which a deep blue is necessary. The blues may be very easily diluted. I have often succeeded in printing blues containing not more than 15 or 17 grammes of blue indigo to the kilogramme of coloring matter. It is very easy to succeed with these pale blues, for the simple reason, that with them one is not so limited as with the deep blues, in regard to the quantity of sodic hydrosulphite to be added, for the color keeps better according as the quantity of the reducing agent is greater.

However prepared, the colors, in order to stand printing properly, that is to say, without oxidizing too much, must be carried to a certain temperature, for it is estalished beyond question that all heated colors can be exposed to the air without its acting on them. The approximate limits of the temperature to accomplish the proposed result, are between 30° and 35° C. It is useless to exceed 35° C., and it would not be safe to work a color whose temperature was below 30° C. I cannot urge too strongly the great importance of working only heated colors. It is in this way that we are able to print eight or ten pieces without emptying the vat, as we shall soon see.

Treatment of the Printed Pieces.

In order that a color may give a good result, it should not be printed too soon. I have noticed that fresh tints which are kept, even to the next day, are the best. It may also be remarked that the thinner the colors are, the more perfect are the results, since they "foam" much less than the thick colors.

It may be added that it is well to heat slightly, especially in winter, the rollers with which the printing is done. When the colors are printed they are spread out until the next day in an airy place, and, strictly speaking, should be passed through tepid water, with a little chromate of potash in it. In the second case they should be washed in a stream of water for a half hour, then washed in the ordinary way in the machines, and washed with soap for half or three-quarters of an hour at 50° or 60° at pleasure.

If the white is no longer desired, we can expose it to chlorine vapor without the slightest trouble. If the blue of the hydrosulphite is associated with other colors for special manufacturers, we can subject the pieces to the operations prescribed for them without paying any particular attention to the blue which is printed on them, for it has been shown that treatment, with crystals of soda or sal soda, sulphuric acid of different degrees of strength, chromate solution, hot or cold, alkaline calcic chromate, sodic silicate, or calcic-potassic phosphate, dung, etc. etc., has no appreciable influence on the blue indigo fixed by the hydrosulphite.

It is often objected to this new color that it is not durable. It is to be sure very liable to rapid changes, both from continual exposure to the air, and from prolonged manipulation. Yet we must add, that a quantity of coloring matter, made at the Cordier establishment, has been sent to England, and given very satisfactory results. Also 12 kilogrammes of coloring matter, made at the same place, were sent to America in a sealed glass vessel. The color was not tried till two months after its arrival, and an excellent result was obtained. In the course of my own researches I have often used color left over three or four days after printing with very satisfactory results. In conclusion, I shall reply to a very serious and prevalent objection, namely, that the process under consideration does not allow more than one piece to be printed without detracting from the clearness of those that follow. As a response to this objection, which does not seem to me well grounded, I can give no other proofs than the result of

my experience. I will exhibit to the Society some samples of the first and eighth pieces printed (in proportion of 1½ kilogrammes of coloring matter to 90 metres), and also from the first and tenth pieces printed (in proportion of 1½ kil. to 90 metres) without emptying the vat. The difference between these samples is very small.

We see then that it is possible, with a little care and practice, to remove the difficulties which the experimenter at first encounters. I can certify, moreover, that we always work under the conditions stated above. It is especially important, other things being equal, to keep in the vat a certain depth of color. When this is done, "foaming" is less to be feared. If it becomes too troublesome, we can empty the vat, for we do not lose all the waste color. All the indigo can easily be recovered by a process which we shall consider hereafter.

To complete what has been already said with regard to the advantages of the new manufacture of fast blue indigo, by means of hydrosulphites, it will be well to point out in this memoir the resources which this new process possesses. Thus we can unite it, without the slightest inconvenience, with the use of aniline black, of naphthylamine puce, of chrome orange, catechu, direct, or with the addition of potassic dichromate, red, violet, puce with garancine, red garancine "resist," with blue "ground," white "resist, with blue "ground," the manufacture of chamois, etc. etc.

(To be continued)

ON THE ADAPTABILITY OF LEAD CONTAINING BISMUTH FOR THE MANUFACTURE OF WHITELEAD.

BY DR. W. HAMPE OF CLAUSTHAL.

Translated by Prof. Frederick Prime, Lafayette College, Easton, Pa.

The refined lead of the Upper Hartz is undoubtedly one of the purest now in the market. The entire amount of impurities does not exceed 0·02 per cent., of which two-thirds are composed of copper, antimony, silver, cadmium, zinc, iron, and nickel, while one-third (or to be more accurate 0·0075 per cent.) consists of bismuth. Since this last metal is the only one occurring in any noticeable quantity in the Hartz lead, it is no wonder that all the supposed failures of this last were ascribed to the bismuth. In particular some whitelead manufacturers asserted that bismuth imparted a tinge of gray to the carbonate made out of Hartz lead, which, it is true, disappeared after grinding and levigation, but the commercial whitelead when used as a paint gradually turned yellow in the dark, which was not the case with other whiteleads, or, at least, not to such a degree. While such an action of bismuth on whitelead was very unexpected from a theoretical standpoint, it still appeared advisable to ascertain by exact experiments whether it was true that oil-paints made of Hartz whitelead turned yellow sooner than those made from other whiteleads, and whether this was due to the bismuth.

In order to attain this end various foreign leads had to be converted into whitelead contemporaneously with Hartz lead and alloys rich in bismuth, and under entirely like conditions; then these whiteleads had to be examined as to their properties and compositions. Mr. Von Duerfeldt, who has since died, superintended with the greatest care and caution, the technical execution of the process at the works of the "Hartz Lead Works Company" at Osterode. For this purpose the Company furnished about five cwts. each of Silesian (Tarnowitz) and Westphalian (Mechernich and Stolberg) leads. These, together with Lautenthal refined lead and bismuth alloys, prepared at the laboratory here, were converted into whitelead under precisely similar conditions. When casting the leads into plates, average samples of each were taken for analysis. After the first oxidation the residual lead-kernels were oxidized a second time, so that whitelead and lead residues were obtained by a second oxidation. These last were also analyzed, since the impression prevails in the factories that the foreign metals present in the lead are concentrated in these residues. The bismuth alloys were made by fusing the purest assay lead with bismuth, and were also analyzed. They contained 0·1 and 0·04 per cent. bismuth, *i.e.*, fifteen and six times as much bismuth as the Hartz lead, while there were only traces of the remaining metals. All the analyses are combined in a table at the end of this memoir. They show, among other things, how variously the different whiteleads are composed. It must be remarked that the analyses of the foreign leads essentially represent the composition of the charges of five cwts., and not the average composition of the lead furnished by the different smelting-works.

The appearance of the carbonate of lead obtained was varied. The bismuth alloys and the Silesian lead afforded a pure white carbonate, while the remainder had a perceptible grayish tinge. This grayish color is probably due to the presence of finely-divided unoxidized lead, since it disappeared after grinding and levigation, and the whitelead produced was of faultless color.

Samples of all the various whiteleads were taken and mixed with the best oil in the proportion of four to one, and then used as paints on glass and wood. These were carefully put away to protect them from dust and light. At the end of four months all the paints had turned slightly yellow; those prepared from the bismuth alloys, the Hartz, and Silesian leads having undergone the least change. After three more months had passed, the yellowish tinges had perceptibly darkened; but there was no regularity as to the intensity of the present tinge compared to the former one; so that many of the paints had turned a deeper yellow than others which had been the darkest at the commencement of the three months. In many of the samples, also, the second products were less changed than the first had been. The samples painted on glass differed also very much from those on wood. It was, however, impossible to perceive that the samples prepared from Hartz whitelead or from bismuthic whitelead were a deeper yellow. It must also be stated that a portion of the Silesian whitelead was mixed with antimony trioxide in the same proportion as that contained in the Hartz whitelead, and then used as a paint. It was not found, however, that these oil-paints had turned a deep darker yellow than the samples prepared with pure Silesian whitelead.

From these experiments it is shown in the most convincing manner, that neither the presence of small quantities of intermixed foreign metals, nor larger quantities of bismuth or antimony in the leads, although these pass into the whiteleads, promotes the turning yellow of the oil-colors. This is merely due, as has been assumed for a long time, to the closing up of the varnish and resin, whenever light is excluded. Luedersdorff* has long since shown that the paints do not turn

* Journal fuer practische Chemie, vol. vi. p. 137.

yellow if a solution of realgar in oil of turpentine and alcohol is used instead of linseed-oil. The fact, too, that this tinge disappears in the light, would seem to favor the idea of the organic nature of the coloring matter. All the paints which turned yellow reassumed their original white tint when exposed to sunlight for twenty-four hours.

Although the foreign ingredients of whitelead do not promote the formation of this yellowish tinge, still hydrated lead oxide does. Grueneberg* has called attention to the fact that whitelead containing more hydrated lead oxide than corresponds to the formula $2(PbO,CO_2) + PbO,HO = 2\left\{\begin{matrix}Pb_3\\CO\\H_2\end{matrix}\right\}O_6$, when mixed with oil, turned yellow after a few hours. Pure hydrated lead oxide, mixed with linseed-oil and varnish, made a good covering paint, which, when kept in the dark, turned lemon-yellow at the end of forty-eight hours. It may easily be ascertained, by means of turmeric paper, whether a whitelead is more basic than the above compound; for if the paper is turned brown by the filtrate, after washing the whitelead, there is free hydrated lead-oxide present. This can readily be removed by levigation with a little acetic acid.

When, however, the above-mentioned whitelead does not react on turmeric paper, and yet gives oil-paints which gradually turn yellow, the reason for the lack of uniformity in the intensity of the yellow tinge may, perhaps, be in some way connected with a somewhat varying quantity of carbonic acid. The intensity of the yellow tinge will then be dependent on the nature of the varnish and basic nature of the whitelead; in no way, however, on the slight quantities of foreign ingredients. These are, indeed, as little in fault as they are in the case of the rose-coloring of the whitelead, which was attributed to copper, silver, and even to iron, until Barrow and Kraemer† showed that it was due, not to these metals, but to a badly-conducted corrosion of the lead in which there was an insufficient access of air, causing the formation of lead suboxide, which then imparted a rosy tinge to the whitelead.

The frequently-observed rapid corrosion of lead pans for evaporating sulphuric acid was in the same way attributed, without any reason, to the presence of foreign metals. Hasenclever‡ showed, however, that it was due to the great purity of the refined lead. Antimonial lead lasted much longer than the other.

Finally, with regard to the frequently-imputed enrichment of the foreign metals in the metallic residues (the so-called lead-kernels) obtained in the preparation of whitelead, it is impossible to give a definite answer to this from the following analyses. It must, however, be borne in mind that such pure leads are not well adapted to settle this question, since the differences are so small that it is impossible to say whether they are essential, or whether they are due to the uncertainty caused by the taking of the samples for analysis from the residues. An enrichment of the bismuth in the finely-divided lead was found only in the bismuth alloys, after separating the residues from the whitelead by washing. Alloy I contained 0·1 per cent. bismuth, and the metal obtained by washing the whitelead contained 0·141 per cent. Alloy II contained 0·0416 bismuth, the residues 0·0574 per cent. This had a peculiar, distinctly crystalline texture and broke easily.

* Polytechnisches Centrallblatt, 1860, vol. xxvi. p. 1404.
† Berlin deutsche chemische Gesellschaft, 1872, No. 12, p. 545; also Berg- und huettenmœnische Zeitung, 1872, No. 30, p. 125.
‡ Polytechnisches Journal, 1872, vol. ccv. p. 125.

Table of Analyses.

Hartz Lead.

Ordinary Hartz whitelead obtained from the factory.

Bi	0·004841 per cent.
Cu	0·001708 "
Sb	0·001236 "
Ag	0·000500 "
Fe	0·002100 "
Zn	0·000305 "
Ni	trace

	Original lead from Lantenthall.	White lead from I oxidation.	White lead from II oxidation.	Lead residues from the II oxidation.
Bi	0·008498 p. c.	0·006276 p. c.	0·008275 p. c.	0·011091 p. c.
Cu	0·000954 "	0·000431 "	0·000447 "	0·001149 "
Sb	0·001184 "	0.000903 "	0·001156 "	0.001334 "
Ag	0·000500 "	0·000500 "	0·000500 "	not determ'd.
Fe	0·004930 "	0·000728 "	0·000660 "	trace.
Zn	0·000361 "	0·000128 "	0.000176 "	
Cd	trace	trace	trace	
Ni				

Silesian Products.

	Original lead.	Whitelead from I oxidation.	Lead residues from II oxidation.
Bi	Trace	Trace	Trace
Cu	0·0012 p. c.	0·000566 p. c.	0·000938 p. c.
Cd	0·00046 "	0·000360 "	0·000500 "
Sb	0·00131 "	0·000444 "	0·001388 "
Ag	0·000166 "	0·000130 "	0·000166 "
Fe	0·00120 "	0·000903 "	0·000360 "
Zn	0·00035 "	0·000257 "	0·00031 "

Mechernich Products.

	Original lead.	Whitelead from I oxidation.	Lead residues from II oxidation.
Bi	0·00022 p. c.	0·000197 p. c.	0·00024 p. c.
Cu	0·00051 "	0·000408 "	0·000411 "
Cd	0·00037 "	0·000200 "	0·000450 "
Sb	0·00320 "	0·002218 "	0·00310 "
Ag	0·00032 "	0·000300 "	0·00038 "
Fe	0·00075 "	0·000937 "	0·000634 "
Zn	0·00032 "	0·000337 "	0·00020 "

Stolberg Products.

	Original lead.
Bi	0·000966 p. c.
Cu	0·00110 "
Cd	0·00056 "
Sb	0·04921 "
Ag	0·00055 "
Fe	0·00066 "
Zn	0·00050 "

Bismuth Alloy I.

	Original alloy.	Whitelead from I oxidation.	Finely-divided lead obtained by levigation after I oxidation.
Bi	0·100000 p. c.	0·078807 p. c.	0.141 p. c.
Cu	0·000626 "	not determined.	not determined.
Sb	0·000224 "		
Fe	0·000443 "		
Zn	0·000804 "		
Ag	0·000050 "		
Cd	0·000802 "		
Ni	0·000053 "		

Bismuth Alloy II.

Original alloy.		Whitelead from I oxidation.	Finely-divided lead obtained by levigation after I oxidation.
Bi . . .	0·041640 p. c.	0·0286 p. c.	0·0574 p. c.
Cu . . .	0·000626 "		
Sb . . .	0·000224 "		
Fe . . .	0·000443 "	not determined.	not determined.
Zn . . .	0·000804 "		
Ag . . .	0·000050 "		
Cd . . .	0·000802 "		
Ni . . .	0·000053 "		

—*Berg-, Huetten-, und Salinenwesen in dem preussischen Staate*, vol. xxi. No. 5.

THE THEORY OF ATOMS IN THE GENERAL CONCEPTION OF THE UNIVERSE.

Opening Address by the President, M. Wurtz, at the Meeting of the French Association.

Francis Bacon conceived the idea of a society of men devoted to the culture of science. In his *New Atlantis*, in which he describes the organization of this society and its influence upon the destinies of a wisely governed people, he shows it rising to the dignity of a State institution. The progress of civilization by the search for truth, and truth discovered in the order of nature by experiment and observation—such are the ends proposed and the means made use of. Thus, in an age when the syllogism was still supreme, and which was firmly held beneath the scholastic yoke, the English Chancellor assigned to science at once its true method and its mission in the world.

The plan of Bacon embraced all branches of human knowledge. The land was overrun by a multitude of observers, engaged, some in studying the monuments of the past, the language, the manners, the history of the nations; others in observing the configuration and the productions of the soil, noting the superficial structure of the globe and the traces of its revolutions, collecting all the data concerning nature, the organization and distribution of plants and animals. Other men, located in various regions, cultivated the exact sciences. Towers were constructed for the observation of stars and meteors; vast edifices, arranged for the study of physical and mechanical laws, contained machines which supplied the deficiency of our forces, and instruments which added to the precision of the senses and rendered abstract demonstrations sensible. This immense labor was uninterrupted, co-ordinated, controlled; it had its origin in self-abnegation, it was regulated by precision, and had time for its sanction. Thus was it fruitful.

Such was the idea of Francis Bacon. To observe all things; by the rational comparison of these observations to disclose the hidden connections of phenomena, and to rise by induction to the discovery of their real nature, and their causes, all with the view "of extending the empire of man over entire nature, and of executing everything possible for him to do;" such is the object which he has pointed out to us; such is the function of science.

This great exploration of the earth which he desired to institute, this patient and exact research of the laws of the universe, this deliberate intervention of science in the affairs of life and of the universe—could all this be the work of his own time? He knew it too well to venture to hope it himself, and it is on this account, doubtless, that he placed the fortunate country which enjoyed so noble an institution in the solitude of the great ocean.

Two centuries and a half ago the conception of Bacon was regarded as a noble utopia; to-day it is a reality. That magnificent programme which he then drew out, is ours, gentlemen; ours, not in the narrow sense of the word, for I extend this programme to all who, in modern times and in all countries, give themselves to the search for truth, to all workers in science, humble or great, obscure or famous, who form in reality, in all parts of the globe and without distinction of nationality, that vast association which was the dream of Francis Bacon. Yes, science is now a neutral field, a commonwealth, placed in a serene region, far above the political arena, inaccessible, I wish I could say, to the strifes of parties and of peoples; in a word, this property is the patrimony of humanity. It is, too, the principal conquest of this country, which my illustrious predecessor characterized, with so much justice, as the century of science.

Modern generations are spectators, indeed, of a magnificent spectacle. For a century past the human mind has directed an immense effort to the study of the phenomena and the laws of the physical universe. Hence an astonishing development of all the sciences founded on observation and experiment. New ideas which have arisen in our days in the correlation and conservation of forces have been like a revelation to some of these sciences. Mechanics, physics, chemistry, physiology itself, have found at once a *point d'appui* and a bond of connection. And this powerful flight of ideas has been sustained by the progress of the methods, I should say by the more careful exactness of observations, the perfect delicacy of experiments, the more rigorous severity of deductions. These are the springs of this movement which hurry along the sciences, and of which we are the astonished and moved witnesses. It is to propagate it broadcast over our country that we hold, each year, this parliament, to which are invited all who take part or are interested in the war against the unknown. Science is indeed a war against the unknown; for, if in literature it is enough to give expression, and in art a body, to conceptions or beauties deposited either in the human mind or in nature, it is not so in science, where truth is deeply hidden. She must be conquered, she must be stolen, like the Promethean fire.

It is of some of these conquests that I wish to speak to-day, full of doubt and apprehension in presence of so great a task. To respond to the demands of his position and to follow noble examples, your president ought, at the beginning of this session and of the ceremonies which inaugurate our young association, to trace the progress accomplished in the sciences, mark by a few bold lines the various routes over which it has recently run, and the culminating points which it has attained. I shrink from such a programme; if it does not exceed the powers of some of my colleagues, and doubtless of some among you, it greatly surpasses mine. Less justified and less daring than was Condorcet at the end of last century, I only perceive the outlines and some bright patches of the sketch which he attempted to draw; and to see it accomplished, I shall call to my assistance those who will follow me in the honorable and perilous post I now occupy.

I shall confine myself, then, gentlemen, to speaking to you of what I know, or of what I think I know, by directing your attention to the science to which I have devoted my life.

Chemistry has not merely grown, it has been regene-

rated since Lavoisier. You know the work of that immortal master. His labors in connection with combustion gave to our science an immovable basis by fixing at once the notion of simple bodies and the essential character of chemical combinations. In these latter we find in weight all that is ponderable in their elements. These, in uniting to form compound bodies, do not lose any of their proper substance; they lose only an imponderable thing, the heat disengaged at the moment of combination. Hence that conception of Lavoisier that a simple body such as oxygen is constituted, properly speaking, by the intimate union of the ponderable matter oxygen with the imponderable fluid which constitutes the principle of heat, and which he named caloric—a profound conception, which modern science has adopted, giving it a different form. It is then unjust that, in recent times, Lavoisier should be accused of having misconceived what is physical in the phenomenon of combustion, and that an attempt should be made to rehabilitate the doctrine of Phlogiston which he had the honor of overturning. It is true that in burning bodies lose something: "It is the combustible principle," said the partisans of Phlogiston; "It is caloric," said Lavoisier; and he adds, an essential thing, that they gain in oxygen.

Thus Lavoisier perceived completely the phenomenon, of which the great author of the phlogiston theory, G. E. Stahl, had only a glimpse of the eternal appearances, and of which he misconceived the characteristic feature. Such is, gentlemen, I maintain, the foundation and the origin of modern chemistry. Is that to say that the monument raised upon these bases by Lavoisier and his contemporaries subsists in all its parts, and that it was accomplished at the end of last century? It would not be from want of materials, and even in its outlines we may notice lines which have in time disappeared. It has been added to and in part transformed; but it still rests upon the same foundations. Such has been in all sciences and in all times the lot of theoretical conceptions; the best of them contain obscurities and gaps which, on disappearing, become the occasion of important developments or of a new generalization.

That of Lavoisier embraced especially the bodies best known in his time, *i. e.*, the compounds of oxygen, the true nature of which was discovered by him in his researches on combustion. All these bodies are formed of two elements; their constitution is binary, but it is more or less complicated. Some, oxides or acids, contain a simple body united to oxygen; others, more complex, are formed by the combination of acids and oxides among themselves, a combination which gives rise to salts. These last then are formed of two constituent parts, each of which contains oxygen united to a simple body. Such is the formula of Lavoisier on the constitution of salts; it is in harmony with the fundamental idea which he enounced on chemical combination, an idea according to which all compound bodies are formed of two immediate elements, which are either simple bodies or themselves compound bodies.

This dualistic hypothesis was embodied, in his time and with his consent, in French nomenclature, the work of Guyton de Morveau, the principle of which may be thus summarized: two words to designate each compound, one to mark the genus, the other the species. Thus, one of the fundamental conceptions of the system of Lavoisier—dualism in combinations—found a striking expression in the binary structure of the names, and is, as it were, insinuated into the mind by the very terms of chemical language; and we know what is, in such a case, the power of words.

The great successor of Lavoisier, Berzelius, extended to the whole of chemistry the dualistic hypothesis of Lavoisier on the constitution of salts. Wishing to give it a solid support, he added to it the electro-chemical hypothesis. All bodies are formed of two constituent parts, each of which possesses, and is, as it were, animated by, two electric fluids. And as the electro-positive fluid attracts the electro-negative, it is natural, it is necessary that in every chemical compound the two elements should reciprocally attract each other. Is not the one carried towards the other by electric fluids of opposite kinds? We see that the hypothesis of Berzelius gives at once a striking interpretation of the dualism in combinations and a simple and profound theory of chemical affinity. This elective attraction which the final particles of matter exercise upon each other was referred to electric attraction.

Another theoretic conception gave a body to the electro-chemical hypothesis, and has given since a solid basis to chemistry as a whole. We speak of the atomic theory, revived from the Greeks, but which took, at the commencement of this century, a new form and a precise expression. It is due to the penetration of an English thinker, Dalton, a teacher of chemistry in Manchester in the beginning of the century. It was less a pure speculation of the mind, as were the ideas of the ancient atomists and of the philosophers of the Castesian school, than a theoretical representation of well-established facts, viz., the parity of the proportions according to which bodies combine, and the simplicity of the relations which express the multiple combinations between two bodies.

Dalton found, in fact, that, in cases where two substances combine in several proportions, if the quantity of one of them remains constant, the quantities of the other vary according to very simple relations. The discovery of this fact was the starting-point of the atomic theory. Here is the substance of this theory: That which fills space, viz., matter, is not infinitely divisible, but is composed of a universe of invisible, imperceptible particles, which, nevertheless, possess a real extension and a definite weight. These are atoms. In their infinitely attenuated dimensions, they offer points of application to the physical and chemical forces. They are not all like each other, and the diversity of matter is owing to inherent differences in their nature. Perfectly identical for the same simple body, they differ from one element to another in their relative weights, and perhaps by their form. Affinity sets them in motion, and when two bodies combine with each other, the atoms of the one are drawn towards the atoms of the other. As this approach always takes place in the same manner between a determinate number of atoms, which are in juxtaposition one to one, or one to two, or one to three, or two to three—in other words, according to very simple proportions, but invariable for a given combination—it results therefrom that the smallest particles of this combination present a fixed composition rigorously similar to that of the entire mass.

Thus the most important fact of chemistry, the immutability of the proportions according to which bodies combine, appears as a consequence of the fundamental hypothesis that chemical combinations result from the coming together of atoms possessing invariable weights. Berzelius compared these atoms to minute magnets. He imagined them to have two poles where the two electric fluids are separated but unequally distributed, so that one of them is in excess at one of the poles. "There exists," he said, "atoms with excess of positive

fluid and others with excess of negative fluid; the first attract the second, and this attraction, the source of chemical affinity, preserves the atoms under all combinations. At the moment that these last are formed they are set in motion; in the completely formed compound they are at rest, and are divided as if into two camps, at once kept together and maintained in opposition by the two electric fluids of opposite kinds.

Thus the electro-chemical theory, ingeniously adapted to the hypothesis of atoms, raised the dualism of Lavoisier to the dignity of a system, which appeared solidly established during the first half of this century. The facts then known were included in it without difficulty, and the rich materials which the patience or the genius of experimenters amassed without ceasing were very soon co-ordinated.

Without attempting to enumerate the older works relating to the decomposition of alkalies, to the nature of chlorine recognized as a simple body, to various newly-discovered elements, such as selenium, tellurium, iodine, we shall mention in a special manner, among so many discoveries, that of cyanogen, which we owe to our own Gay-Lussac. The demonstration of the chemical functions of this compound gas, which behaves like a simple body, which is capable of forming the most varied combinations with true elements, which finally, when it is engaged in such combinations, lends itself to double decompositions, as does chlorine in the chlorides, was a great step in the progressive march of science. Hence the definition: cyanogen is a compound radical, and the triumphant appearance of the doctrine of radicals. It had been vaguely intimated by Lavoisier; it really dates from the discovery of cyanogen, and will make a rapid advance. Up to that time great efforts had been directed to the side of inorganic chemistry, and great ideas had arisen in this domain. The application of these ideas to organic chemistry, upon which attention then began to be directed, presented some difficulties.

We know that the innumerable bodies which nature has distributed in the organs of plants and animals contain a small number of elements—carbon, hydrogen, oxygen, and often nitrogen. It is then not in their general composition that they differ, but by the number and arrangement of the atoms which enter into their composition. By increasing more or less and grouping themselves in various manners, these atoms give rise to an immense multitude of distinct compounds which are true chemical species. But what is the arrangement of these atoms? What is the structure of these organic molecules, so much alike in the nature of their elements, so wonderful in the infinite diversity of their properties? Berzelius solved this question without hesitation. Comparing organic compounds to the bodies of inorganic chemistry, he divided both classes of atoms into two lots, grouping on one side carbon and hydrogen, electro-positives, and on the other, oxygen, electro-negative. And when, at a later time, chlorine was artificially introduced into organic compounds, the atoms of this powerful element were ranged on the side of oxygen, both being invariably found in binary combinations of which they formed the electro-negative element, the atoms of carbon and hydrogen constituting the electro-positive radical.

Thus the great promoter of inorganic chemistry attempted to fashion organic molecules according to the image of those molecules of dead matter which he had studied so thoroughly. The paths which Lavoisier traced in this domain he wished to extend to the world of products formed under the influence of life; they resulted in a dead-lock. In proportion as the riches of science increased it was necessary, in order to uphold the system, to accumulate hypotheses, to invent radicals, to construct, with insufficient or imaginary data, formulæ more and more complicated—a thankless task, in which the feeling of experimental realities and sober appreciation of facts often gave place to outrageous reasonings and vague subtleties. These barren efforts of a great mind inaugurated the decline or marked the termination of the dualistic ideas which were at the foundation of what has been called, improperly perhaps, the old chemistry. The new began at that point. Great discoveries, cleverly and boldly interpreted, gave it an impulse which still endures.

There were then—I speak of forty years ago—a number of young men, with Dumas and Liebig at their head, in the opposite camp, who cultivated with ardor the investigation of organic compounds. Convinced that the constitution of these compounds could only be deduced from the attentive investigation of their properties and metamorphoses, they undertook to investigate these bodies themselves, to transform them, to torment them in some sort by the action of the most diverse reagents, in the hope of discovering their intimate structure. And this is, gentlemen, the true method in chemistry; to determine the composition of bodies, and by careful analysis of their properties to fix, as far as possible, the grouping of their ultimate particles. This, then, is the glory of our science, and the single but precious contribution which it is able to furnish for the solution of that eternal problem, the constitution of matter.

From the researches which were made at this epoch and in this spirit, an all-important fact issued; it relates to the action of chlorine on organic compounds. This simple body deprives them of hydrogen and may be substituted for that element, atom for atom, without affecting the molecular equilibrium and without, adds Dumas, modifying the fundamental properties. This proposition encountered at first the most violent contradiction. How could chlorine take the place of hydrogen and play its part in combinations? These two elements, said Berzelius, are endowed with opposite properties, and if the one is lacking the other cannot supply its place; for, in short, they are two inimical brothers, little disposed and by no means fit to be kept in the same house. These critics and many others have not prevailed against facts. The theory of substitution has come triumphantly out of this great discussion, which marks a date in the history of our science. Its natural development has gradually introduced into it new ideas on the constitution of chemical compounds, on the mode of combination of the elements which they contain.

These ideas have come to light by various ingenious comparisons. Laurent considered organic compounds as formed of nuclei with appendages, both the one and the other admitting into their structures atoms grouped with a certain symmetry. Dumas compared them to edifices of which the atoms constitute, in a manner, the materials. Hence the graphic but frequently correct expression, of molecular edifices capable of being modified, in certain cases, by the substitution of one part for another, and which, in other cases, the shock of powerful reagents may shatter to pieces. In both conceptions the chemical molecules were regarded as forming a whole. A little later Dumas compared them to planetary systems; and here he veritably shot ahead

of his time in giving a glimpse of groups of atoms maintained in equilibrium by affinity, but carried along by movements, as the planets of a solar system are acted upon by gravitation and carried into space. It is in these movements of atoms and molecules that at a later period the source of the physical and chemical forces must be sought for; but I must not anticipate. I have attempted to show how the ideas on chemical combinations have been gradually modified under the double influence of the atomic hypotheses and of facts brought to light by the French school concerning their reciprocal replacement in combinations. Forming a whole, more or less complex, the molecules of organic substances may be modified by substitution and give rise to a multitude of derivatives which naturally attach themselves to the mother substance. The latter serves them as a model or type. The typical idea thus introduced into science very soon occupied a large place. It first brought to it important elements of classification. All the compounds derived by substitution from the same body were ranged in the same family, of which the latter was, so to speak, the chief. Hence arose groups of bodies perfectly distinct from each other, and the number of which were being constantly increased by daily discoveries. It was necessary not only to introduce order into all these tribes, but to connect them with each other by a common bond. The honor of having discovered the superior principle of classification belongs to Laurent and Gerhardt, valiant champions of French science, from whom premature death has snatched, if not victory, at least the gratification of victory. Laurent was the first to say that a certain number of mineral and organic compounds possessed the constitution of water, and this idea, brilliantly developed by Williamson, was generalized by Gerhardt. According to the last named, all inorganic and organic compounds may be connected with a small number of types, of which hydrochloric acid, water, and ammonia are the chief. In these compounds, relatively simple, one element may be replaced by another element, or by a group of atoms performing the function of a radical, so that this substitution gives rise to a multitude of various compounds bound together by the analogy of their structure, if not by the harmony of their properties.

This last point was novel and important. Bodies belonging to one type and similar in their molecular structure may differ much in their properties; these depend not only on the arrangement of the atoms, but also in their nature. Thus the inorganic and organic bodies ranged under the type water, are, according to the nature of their elements or their radicals, powerful bases, energetic acids, or indifferent substances—a great and bold idea, which has established a connection between the most diverse bodies, and which has definitely overturned the barriers which use had raised, and which the weakness of theory had maintained, between inorganic and organic chemistry. And yet this was only a stage in the march of ideas. By what right and by what privilege, it was said, may the relatively simple compounds we have named serve as types for all others, and why should nature be restricted to make all bodies on the model of hydrochloric acid, water, and ammonia? This was a serious difficulty, but it has been removed; it became the occasion of a profound discussion and the germ of a real progress.

These typical compounds represent at bottom various forms of combination, the diversity of which it is necessary to refer to the nature of the elements themselves. The latter impress on each of these compound types a particular character and a special form. The atoms of chlorine are so formed that to one of them only a single atom of hydrogen needs to be added to form hydrochloric acid: then that an atom of oxygen takes two atoms of hydrogen to form water; that an atom of nitrogen requires three to constitute ammonium; and that an atom of carbon demands four to become marsh-gas. What a difference in the power of combination of these elements, and, so to speak, in their appetites for hydrogen! And will this difference not be connected with some peculiarities in their mode of existence, to some property inherent in matter itself, and which will impress on each of these hydrogenic compounds a special form? Such is the case.

It is now admitted that atoms are not motionless, even in bodies apparently the most fixed and in completely formed combinations. At the moment when these are being formed the atoms come into violent collision with each other. In this conflict a disengagement of heat is ordinarily observed, resulting from the expenditure of active energy which the atoms have lost in the *mêlée*, and the intensity of this heat-phenomenon gives the measure of the energy of the affinities which have presided at the combination. But there is another thing in chemical phenomena besides the intensity of the forces at work, and which are more or less exhausted by a disengagement of heat; I refer to their *mode;* it was of this elective attraction that Bergman spoke a century ago, and which governs the form of the combinations. The atoms of the various simple bodies are not endowed with the same aptitude for combination with each other; they are not equivalent to each other. This is what is called atomicity, and the fundamental property of atoms is without doubt connected with the various modes of motion by which they are animated. When these atoms combine with each other, their movements require to be reciprocally co-ordinated, and this co-ordination determines the form of the new systems of equilibrium which will be formed; that is, the new combinations.

It is with atoms thus endowed that chemists now construct molecular edifices. Resting at once upon the data of analysis and on the investigation of reactions, they express the composition of bodies by formulæ which mark the nature, the number, and the arrangement of the atoms which each molecule of these bodies contains. But what! is this merely an ingenious exercise of the mind? and the construction of formulæ by means of these symbolic materials which are selected, which are arranged so as to give to the molecular edifice a determined form—is this a mere matter of curiosity? By no means. These formulæ, by whose aid are expressed the composition of bodies and the constitution of their molecules, offer also a valuable aid for the interpretation of their properties, for the study of their metamorphoses, for the discovery of their reciprocal relations—all things which are intimately connected in each body with the nature and arrangement of the atoms. Now, the investigation and comparison of these formulæ furnish to the inquiring spirit the elements of a powerful synthesis. What treasures have been acquired by science by this process, which consists in deducing the transformations of bodies from their molecular structure, and in creating, by a sort of intuition, new molecules by means of those already known! The artificial formation of a number of combinations, the syntheses of as many organic compounds as nature alone seemed to have the privilege of forming—in a word, the greater part of chemical discoveries which

have enriched science and the world for twenty years—are founded on this inductive method, the only efficacious and the only rational one in the sciences. I shall cite only one example among many others.

A happy chance led to the discovery of that brilliant substance, of a bright purple, which is known under the name of fuchsine or rosaniline Analysis determines its composition, skilled investigations find its molecular structure. Soon it is known how to modify it, to multiply the number of its derivatives, to vary the sources of their production, and from attentive study of all these reactions, issue a pleiad of analogous substances whose diverse colors rival in brilliancy the richest tints of the rainbow. A new and powerful industry has already resulted from all these investigations, which theory has followed step by step and guiding the fertile evolution. In this order of investigation, science has recently gained one of her most striking triumphs. She has succeeded in forming at once the coloring matter of madder (alizarin). By an ingenious combination of reactions, and by theoretic reasonings still more ingenious, MM. Graebe and Liebermann have succeeded in obtaining this body synthetically, by means of anthracene, one of the numerous bodies which is now obtained from coal-tar, the impure source of so many wonders. Such is a discovery which has issued from the womb of science, and of science the most abstract; confirming preconceived ideas on the relations of composition and of atomic structure between anthracene, alizarin, and the intermediate terms. And this will not be the last product of this beautiful development of chemistry. Future conceptions on the intimate structure of complex organic compounds will be so many landmarks for new syntheses, and hypotheses rigorously deduced from acquired principles will be fruitful in the happiest applications.

Saccharine matters, alkaloids, other complex bodies whose properties and diverse transformations are actively investigated, with a view of deducing their molecular constitution—all these substances may be artificially reproduced, as soon as this preparatory work, so difficult and often seemingly so useless, will have sufficiently advanced. So fine a programme justifies the great efforts which have been made, in our days, in this direction. To discover, to analyze, to study, to classify, to reproduce artificially so many diverse substances, to study their internal structure, to indicate their useful applications; to surprise, in a word, the secrets of Nature and to imitate her, if not in her processes, at least in some of her productions—such is the noble aim of contemporary science. She can only reach it by the sure but slow paths we have indicated; experiment guided by theory. In chemistry, at least, empiricism has had its day; problems, clearly stated, must be boldly faced, and henceforth the rational conquests of experiment will only leave a place more and more circumscribed for fortunate finds and the surprises of the crucible. Away, then, with the detractors of theory, who go in quest of discoveries which they can neither foresee nor prepare; they reap where they have not sown. But you, courageous workers, who trace methodically your furrows, I congratulate you. You may be sometimes deceived, but your work will be fruitful, and the goods which you amass will be the true treasure of science.

Will not this science be one day embarrassed, and as if encumbered with so much riches, and will the strongest memory be able to support all the weight? If the danger exists, there is no need to fear it. The classification of all these materials will free us from embarrassment. In a well-arranged edifice, each stone requires to be prepared before taking its place: but the construction accomplished, all do not strike the eye equally, though each has its use; only the strong courses, the corner-stones, and the salient parts, are noticed. It will be thus with the monument of science. The details which have for their end to fill up gaps will disappear in the great whole, of which we only need consider the foundation, the principal lines, and the crowning of the edifice.

Gentlemen, chemistry thus constituted, and physics, have between them necessary connections. Both the one and the other investigate the properties of bodies, and it is evident that, so far as the ponderable bodies are concerned, these properties must be intimately connected with the constitution of matter. Hence the atomic hypothesis which suffices for the interpretation of chemical phenomena ought also to be adapted to physical theories. This is the case. It is in the movements of atoms and of molecules that we now seek, not only the source of the chemical forces, but the cause of the physical modifications of matter, changes of condition which it can undergo, phenomena of light, of heat, of electricity, of which it is the support.

Two French *savans*, Dulong and Petit, discovered some time ago a very simple law which connects the weights of atoms with their specific heats. It is known that the quantities of heat necessary to change by one degree the temperature of the unit of weight of bodies are very unequal. This is what we call specific heats; but the quantities of heat which bring about in simple bodies, taken under conditions in which they are rigorously comparable, the same variations of temperature, are equal, if we apply these quantities of heat not to the unit of weight but to the atomic weight; in other words, the atoms of these elementary bodies possess the same specific heats, though their relative weights are very unequal.

But as to this heat which is thus communicated to them, and which raises their temperature equally, what is in reality its mode of action? It augments the intensity of their vibratory movements. Physicists recognize heat as a mode of motion, and that it comes under the cognizance of our perceptions by the vibrations of atomic matter or ether; of ether, that fluid material, perfectly elastic, incoercible, imponderable, which fills all the immensity of space and the depth of all bodies. It is in this fluid that the stars describe their orbits: in this fluid atoms perform their movements and describe their trajectories. Thus the ether, the radiant messenger of heat and light, conveys and distributes their radiations through all the universe; and that which it loses in vibratory energy when it penetrates a cold body, which it warms, it communicates to the atoms of this body and augments the intensity of their movements; and that which it gains in energy by contact with a warm body, which it cools, it withdraws from this body and diminishes the intensity of their vibratory movements. And this kind of light and heat which come from material bodies is transmitted across space to other material bodies. You will remember in reference to this the words which Goethe put into the mouth of the Prince of Darkness in cursing the light—"It is born of bodies, it is brought forth and maintained by bodies, and it will perish with them."

But this exchange of forces which circulate from ether to atoms and from atoms to ether, must it manifest itself always in the phenomena of light or heat?

This vibratory force which is transmitted by ether, can it not be preserved and stored up by matter, or appear under other forms?

It can be preserved as affinity, liberated as electricity, transformed into dynamic movements. It is this which is stored up in the innumerable compounds elaborated by the vegetable kingdom; it is this which provokes the decomposition of carbonic acid and of the vapor of water by the most delicate organs of plants which blossom in the sunlight. Originating with the sun, luminous radiation becomes affinity in the immediate organic principles which are formed and accumulated in vegetable cellules. That mode of motion of ether which was "light," is become another mode of motion which is "affinity," and sways the atoms of an organic compound. In its turn this force thus stored up is expended again when the organic compounds are destroyed in the phenomena of combustion. Affinity, satisfied and as it were lost by the combination of combustible elements with oxygen, again becomes heat or electricity. Wood in burning, and carbon in becoming oxidized, produce sparks or flames; a metal which exhausts its affinities in decomposing an acid warms the liquid, or, under other conditions, produces an electric current, warming it less when the current is exterior. And in another order of phenomena, heat which distributes or propagates itself unequally between two surfaces, rubbing one against the other, or in a crystal that is warmed, or in two metals united by solder, disappears partially as such, and manifests itself as static electricity or as an electric current. Thus all these forces are equivalent to one another, and appear under diverse forms, whether they are passing from atoms to ether or from ether to atoms; but we never see them disappear or lose their force—only transform themselves and perpetually renew their youth.

And this is not all. These vibratory movements which sway atoms and which whirl about in ether, can cause movements of the mass, displacement either of the bodies or of the molecules. Warm a bar of iron, it will dilate with a force almost irresistible; a part of the heat will be employed in producing a certain pulling asunder of the molecules. Warm a gas, it will in like way dilate, and a part of the heat, disappearing as such, will produce a separation very considerable in this case between the gaseous molecules; and the proof of the consumption of heat in the work of dilation is not difficult to give, for if you warm the same gas to the same degree, but prevent it from dilating, less heat need be given to it than in the former case. The difference between the two quantities of heat corresponds exactly to the mechanical work performed by the molecules in dilatation. That is one of the most simple considerations, on which is founded the principle of the mechanical equivalent of heat so often now referred to in mechanics, in physics, and in physiology.

In physics it explains the mystery of latent heat, of fusion, and of volatilization. But how is it that heat supplied continuously to a boiling liquid to maintain ebullition, does not ever raise the temperature of the liquid above a point which, under similar pressure, remains fixed? The reason is that this heat is continually absorbed, and disappears as such to produce the mechanical work of driving apart the molecules. And so in the phenomena of fusion, the constancy of the temperature indicates the absorption of the heat consumed in molecular work. These conceptions have modified and thrown much light on the definitions which physicists have applied to different states of matter, and it is seen that they are in harmony with chemical theories of the constitution of bodies. These are formed of molecules which represent systems of atoms animated by harmonic movements, and whose equilibrium is exactly maintained and strengthened by these movements.

Applied to molecules thus constituted, heat can produce three different effects. In the first place, an elevation of temperature by the increase of vibratory energy; in the second place, an increase of volume by the driving apart of atoms and molecules, and, this augmentation becoming very considerable, a change of condition, solid becoming liquid, and liquid becoming gas; in the last, the driving apart of the molecules is become immense in relation to their dimensions. Thus acting on the atoms which compose the molecule, and amplifying their trajectories, heat can disturb the equilibrium which exists in the system, causing a conflict of these atoms with those of another molecule in such a way that this disturbance or this conflict leads to fresh systems of equilibrium, that is, to new molecules. There commence the phenomena of decomposition and dissociation, or, inversely, of combination, which is the mainspring of chemistry, and it is seen they are but the continuation or consequence of the physical phemomena we have just analyzed, the same hypothesis, that of atoms, applied to one and the other with an equal simplicity.

I ask, will it not be easy to conceive that the physical and chemical forces which act on ponderable bodies are applied also to diffuse continuous matter in some way, and is it not natural to suppose that there are limited and definite particles which represent the points of application of all these forces? And this view ought to apply to the two sorts of matter which form the universe, ether and atomic matter, the one infinitely rarefied but homogeneous, filling all space, and in consequence enormous in its mass, both unseizable and imponderable; the other non-continuous, heterogeneous, and only occupying a very limited portion of space, although it forms all worlds.

Yes, it forms all worlds, and the elements of ours have been discovered in the sun and in the stars. Yes, the radiations given off by incandescent atomic matter, which forms these stars, are also, for the most part, those which are produced by the simple bodies of our planet. Marvellous conquest of physics, which reveals at once to us the abundance of forces which environ the sun and the simplicity of the constitution of the universe!

A solar ray falls upon a prism, and is turned aside in its path and decomposed into an infinity of different radiations. These take each a particular direction, and all range themselves in bands in juxtaposition, and spread themselves out in the spectrum if the light thus received and decomposed is thrown upon a screen. The visible part of this spectrum shines with all the colors of the rainbow; but besides this, beyond both ends of the colored bands, the radiations are not absent. The heat-rays can be made to reveal themselves beyond the red; the chemical rays, more powerful than the others to make and destroy the chemical combinations, are known beyond the violet. All the forces which manifest themselves on the surface of our globe, as heat, light, and chemical energy, are sent to us in a ray of white light.

But this brilliant spectrum is not continuous. Fraunhofer has discovered in it an infinity of black lines cutting the shining band; these are the "dark lines" of the spectrum, and Kirchoff has found that a certain

number of them occupy the same position as the "bright lines" which occur in the spectra of metallic substances when in a state of incandescence. This last physicist, generalizing an observation of Foucault, has seen, further, that under given circumstances these bright lines can be obscured and "reversed," coinciding then with the dark lines of the solar spectrum.

We have been able to conclude that these have an identical origin, and are due to radiations given off by metallic substances spread in vapor over the solar globe, radiations which are obscured by these same vapors in the atmosphere of the sun. Thus the star which gives us heat, light, and life, is formed of elements like those which form our globe. These elements are hydrogen and metals in a state of vapor. They are not distributed equally in the mass of the sun and in his rarefied envelopes; the hydrogen and most volatile metals are raised to a greater height on the surface of the sun than are the other metals. They are never in repose; this ocean of incandescent gas is continually agitated by tremendous tempests. The *trombes* throw themselves out in immense columns, to the height of 50,000 leagues above the gaseous sphere; these are the "protuberances," and they shine with a rose light peculiar to themselves; and they are formed, according to Janssen and Lockyer, by hydrogen, very rarefied, and also by an unknown substance—"helium." The luminous globe itself, the photosphere, gives the spectra of our ordinary metals, except gold, silver, platinum, and mercury; the precious metals, those which have little affinity for oxygen, being wanting. But, on the contrary, in the solar spectrum there are "lines" different from those which the metals of our earth give, but which are like them. The lines of the metalloids are wanting, as are the lines which are characteristic of compound bodies. The gaseous mass has such an incandescence that no chemical combination could withstand it.

The lines of Fraunhofer are dark, only the lines of the protuberances and those seen a moment after the disappearance of the sun in an eclipse, and a moment before its reappearance, are bright, like those which characterize the spectra of incandescent metallic vapors. Here we have a curious relationship which has furnished most important and precise indications on the physical constitution of the sun.

I have spoken of the chemistry of the sun, but the spectroscope has explored all the far-off space of heaven. The light of hundreds of stars has been analyzed, and nebulæ, scarcely visible, have had the quality of their radiations revealed by its aid. The light, in some cases very feeble, with which a number of stars shine, gives a spectrum with dark lines like the solar spectrum, and this fact proves to us that the constitution of these stars is like that of our sun. Aldebaran sends us records of hydrogen, magnesium, and calcium, which abound in solar light, but also those of metals which are rare or absent, as tellurium, antimony, and mercury.

Nebulæ, twenty thousand times less brilliant than a candle at a distance of 400 metres, have still given a spectrum; for their light, although feeble, is very simple in its constitution, and the spectrum which it gives consists only of two or three bright bands, one of hydrogen, the other of nitrogen. Those nebulæ which give a spectrum of bright lines, are those which the most powerful telescopes cannot resolve; there is an "abyss" between them and resolvable nebulæ which, like ordinary stars, give a spectrum with dark lines.

What an effort of the human mind! To discover the constitution of stars of which the distances even are unknown; of nebulæ which are not yet worlds; to establish a classification of all the stars, and still more to guess their ages—ah, tell me, is not this a triumph for science? Yes, we have classed them according to their ages. Stars colored, stars yellow, stars white; the white are the hottest and the youngest; their spectrum is composed of a few lines only, and these lines are dark. Hydrogen predominates. Traces of magnesium are also met with, of iron, and perhaps of sodium; and if it is true that Sirius was a red star in the time of the ancients, it owed perhaps its tint to the greater abundance of hydrogen at that epoch. Our sun, Aldebaran, Arcturus, are among the yellow stars. In their spectra the hydrogen lines are less developed, but the metallic lines are fine and numerous. The colored stars are not so hot, and are older. In consequence of their age they emit less vivid light. In them there is little or no hydrogen. Metallic lines abound, but one also finds channelled spaces like the lines of compounds. The temperature being lower, these latter can exist whether they consist of atoms joined to others of the same kind, or whether they contain groups of heterogeneous atoms. In referring recently to this classification of Father Secchi, and the distribution of simple bodies in distant stars, Lockyer has observed that the elements the atoms of which are lightest are, to be found in the hottest stars, and that the metals with high atomic weights are, on the contrary, met with in the colder stars; and he adds this: Are not the first elements the result of a decomposition brought about by the extreme temperatures to which the latter are exposed, and, taking them altogether, are they not the product of a condensation of very light atoms of an unknown primordial matter, which is perhaps ether?

Thus is brought forward afresh, from considerations taken from the constitution of the universe, this question of the unity of matter which chemistry has before raised from a consideration of the relative weight of atoms. It is not solved, and it is probable that it never will be in the sense here indicated. Everything leads to the belief in the diversity of matter, and the indestructible, irreducible nature of atoms. Does it not require, as M. Berthelot has pointed out, the same quantity of heat to put them in motion, whether they are heavy or light, and ought not the law of Petit and Dulong to prevail in its simplicity against the opposite hypothesis, however ingenious it may be?

I have endeavored, gentlemen, to trace out for you the most recent progress accomplished in chemistry, in physics, and in physical astronomy, sciences so diverse in their object, but which have a basis in common—matter—and one supreme object—a knowledge of its constitution and of its properties and of its distribution in the universe. They teach us that the worlds which people infinite space are made like our own system, and that this great universe is all movement, co-ordinated movement. But, new and marvellous fact, this harmony of the celestial spheres of which Pythagoras spoke, and which a modern poet has celebrated in immortal verse, is met with in the world of the infinitely little. There also all is co-ordinated movement, and these atoms, whose accumulation forms matter, have never any repose; a grain of dust is full of innumerable multitudes of material unities, each of which is agitated by movements. All vibrates in the little world, and this universal restlessness of matter, this "atomic music," to continue the metaphor of the ancient philosopher, is like the harmony of worlds; and is it not true that the imagination is equally bewildered, and the spirit equally

troubled, by the spectacle of the illimitable immensity of the universe, and by the consideration of the millions of atoms which people a drop of water? Hear the words of Pascal: "I wish to picture not only the visible universe, but the immensity of nature that one can conceive within the limits of an atom; one may picture there an infinity of worlds, where each has its firmament, as in the visible universe."

As to matter, it is everywhere the same, and the hydrogen of water we meet with in our sun, in Sirius, and in the nebulæ, everywhere it moves, everywhere it vibrates, and these movements, which appear to us inseparable from atoms, are also the origin of all physical and chemical force.

Such is the order of nature, and as science penetrates it further, she brings to light both the simplicity of the means set at work and the infinite variety of the results. Thus, through the corner of the veil we have been permitted to raise, she enables us to see both the harmony and the profundity of the plan of the universe. Then we enter on another domain which the human spirit will be always impelled to enter and explore. It is thus, and you cannot change it. It is in vain that science has revealed to it the structure of the world and the order of all the phenomena; it wishes to mount higher, and in the conviction that things have not in themselves their own *raison d'être*, their support and their origin, it is led to subject them to a first cause—unique, universal God.—*Nature.*

A SINGULAR CASE OF CORROSION OF A TIN TANK.

BY S. P. SHARPLES.

In June, 1872, I received a letter from the Collins Company, of Collinsville, Conn., of which the following is an abstract:—

This company has a hotel building in this place, supplied with very good spring water, which is conducted through, say, 100 feet of lead pipe, from the cement pipe main in the street, to a very large tank or reservoir on an upper floor in the hotel. From this tank water is distributed all over the house, through lead pipes. Water is continually running into the tank, and of course is freely drawn off to the various points. The tank is lined with what the plumber calls pure block-tin. We observe that the water deposits white streaks, at various levels, around on the lining. Inclosed we send you a specimen of the tin lining and the white deposits or powder.

A waste pipe, 9 feet long by 2 inches in diameter, is within the tank, and subject to the action of the water.

Is the white powder from lead or any corrosive metal?

Subsequently they forwarded me specimens of the water taken from the spring, from the place where the lead pipe discharged into the tank, and from the place where it was drawn for use in the house.

The water taken directly from the spring was examined, and gave 5·3 parts inorganic matter, and 2·5 parts organic matter, to the 100,000 parts of water.

The inorganic portion was mainly carbonate of lime, with a little sulphate of lime and chloride of sodium. The specimens of water drawn from the lead pipes were entirely free from even traces of that metal. The white powder referred to was found to be oxide of tin, with a mere trace of iron. I accordingly reported that I did not think any harm would arise from the use of the water—as the water was a pure one, and free from lead—and that oxide of tin was not regarded as injurious.

On the 27th of March, 1874, the superintendent of the works again wrote as follows:—

"We inclose specimens of the lining of the tank which contained the water, of the purity of which we were suspicious. We may be mistaken, but it does seem to us that the lining has been destroyed by the action of the water in a most unusual manner. The tank lining has lasted only five years. There has been a free and ample circulation of fresh water constantly in use in the daytime, at the hotel, where our tank is located; and yet, for some cause unaccountable to us, the lining (which is block-tin) is perfectly riddled by corrosion, and must be replaced by a new one of some kind."

In answer to further inquiries on my part, he forwarded another specimen of the water, and a large piece of the lining of the tank, and further wrote:—

"The water is collected at the spring, in a sheltered and ventilated reservoir, with cement lining, and is conducted therefrom in a large cement pipe through our main streets. House pipes of lead are attached all along."

The water from the end of the pipe, where it discharged into the tank, was again analyzed, with the following results:—

Inorganic matter, 4·20; organic matter, 0·80 parts, in 100.000. Was perfectly free from nitrates; and, as the analysis shows, was rather better than when first examined. The lining is commercial block-tin, containing less than 2 per cent. of impurities.

Instances of corrosion of lead are not uncommon; but I have failed, so far as I have investigated, to find a case parallel to this. Professor Chandler,* in an article on the use of tin-lined lead pipe, says, in speaking of tin-lined lead pipe: "Waters which take up one to two-tenths of a grain per gallon from lead pipe are not perceptibly affected by remaining for considerable lengths of time in the tin-lined pipes." And in another place, Mr. Cassamajor† states that tin is slightly more electro-negative than lead; and that it at first starts a feeble galvanic current, which serves to cover the lead with a coating of oxide, and then all action ceases.

Dr. Lankester‡ states, in regard to the tin-lined lead pipes: "I have tested these pipes with great care, and have exposed them to the action of water of various kinds. In no case have I discovered in the water the slightest trace of lead or tin. I have submitted the pipes to the action of distilled water, Thames water, water from artesian wells in London, and to water highly charged with organic matter; and in no case, where these waters have been exposed to the usual reagents for detecting the presence of tin or lead, has the slightest quantity of these metals been detected."

Field§ states that tin does not oxidize at ordinary temperatures in the air, and but very slightly in water, retaining its metallic lustre for a long time; and, again, it is not sensibly affected by the combined presence of air and moisture.

This extensive corrosion of the metal seems, therefore, to be a hitherto unrecorded circumstance, tin being generally regarded as the least liable to change of all our common metals. The metal, as will be seen, is entirely eaten through in some places.—*Proc. Am. Acad. Arts and Sci.*

* Am. Chem., vol. ii. p. 282.
† Am. Chem., vol. i. p. 3.
‡ Am Chem., vol ii. p. 27.
§ Watts' Dict., vol. v. pp. 803-4.

SILICATE PAINT.

An extremely curious local deposit of almost pure silica was recently discovered in one of the hills in North Wales. The deposit lies in a basin of volcanic origin, at a considerable level above the sea, and forms the bed of a small lake about two miles in length and one mile in width. The silica bed has a thickness of several feet, and overlies a second deposit of greater thickness but of less purity.

The analytical chemists speak of the material as a great natural curiosity, and Professor Flageolet, of Paris, presents the following analysis:—

	Parts.
Silica	79
Water	13
Oxide of iron	3
Alumina	4
Magnesium	1
	100

He states that, so far as his experience extends, the material is unique, and points out that it possesses a wide range of usefulness in the arts and manufactures. Thus it would be especially suited for producing crystal glass, and in the manufacture of porcelain, especially if the small percentage of oxide of iron were removed from it. Again, the chemists of the Liverpool Assay Office report that they consider this earth as the most peculiar and interesting material that has come under their notice, and they agree in stating that it is almost pure silica thoroughly calcined, and reduced to such an impalpable powder as to be, without further treatment, fit to be employed in many ways.

The material, when excavated, is freely washed in water, which holds it in partial suspension, and is then allowed to dry, when it becomes brilliantly white, and is more finely divided than could be done by any mechanical means.

At present the only use made of this silica is in the production of paint. For this purpose it is especially suitable, as it mixes freely with the pigments and oils, and is worked with the greatest ease. Moreover, it entirely resists the action of any acid, and withstands the effect of heat. Added to these advantages are those no less important, that the paint has no metallic base in its composition, and that when laid on, it becomes extremely hard, and polished on the surface; and it will be understood that, were there no other purposes to which this curious material could be devoted, the manufacture of paint, comprising the advantages mentioned above, is no small matter. The proprietors of this deposit have for some little time past been producing this paint at the works of the Silicate Paint Company, Fenwick Street, Liverpool, and extended trials have been obtained with it. Amongst others, the Trinity Board of Hull, the Austrian Lloyds of Trieste, the Admiralty, and the Milwall Dock Engineering Company are using it extensively. But although this is one of the most obvious uses to which the almost inexhaustible supply of silica can be put, there remain many others, and we think there can be little doubt that before long an extended use will be found for it in numerous instances.—*Engineering.*

IMPROVEMENT IN PURIFYING ILLUMINATING AND OTHER GASES.

BY BENJAMIN SILLIMAN, OF NEW HAVEN, CONN.

Specification forming part of Letters Patent, No. 153,727, dated Aug. 4, 1874; application filed July 15, 1874.

To all whom it may concern:—

Be it known that I, Benjamin Silliman, of New Haven, county of New Haven, and State of Connecticut, United States of America, chemist, have invented an Improved Process for the Purification of Illuminating and other Gases, and the removal and economical preservation of ammonia mingled with such gases, of which the following is a specification:—

This invention relates to that class of processes, employed for removing ammonia and its compounds and other impurities mixed with and produced in illuminating and other gases in the process of their manufacture; and it consists in the use of certain acid salts placed in the path of the gas for the purpose of removing ammonia and other impurities.

In carrying out my invention, I take the bye product of acid and alkali works known as "salt cake," and place it in layers of convenient thickness, in boxes or other form of purifying apparatus familiarly known to gas-engineers and such as are now in use for what is known as "dry-lime purification" or "oxide-of-iron purification," causing the gas as it comes from the hydraulic main to pass through the apparatus properly charged with salt-cake reduced to a suitable degree of fineness. This agent completely and immediately removes from the gas all ammoniacal compounds, retaining them in chemical combination in a dry state, gaining thereby an increased value in proportion to the ammonia absorbed and combined.

As all gas engineers and chemists know, the complete removal of the ammoniacal compounds from coal-gas has presented hitherto great and insurmountable difficulties, involving, by the use of water for this purpose, a serious loss of illuminating power in the gas, due to the removal by water of some of its most valuable constituents. By the use of my invention this loss is avoided. All the ammoniacal compounds are withdrawn, the illuminating power of the gas is increased, and the expense of water, which in extensive gas-works is very large, is saved to a great extent.

Salt-cake, so-called, is a bye product in the manufacture of acids and of soda, and varies in composition accordingly. That derived from the decomposition of South American saltpetre by oil of vitriol in producing nitric and sulphuric acid contains a residue of free nitric acid and of sulphuric acid from the excess of that agent used in the process. This is nitric-acid salt-cake. More rarely potassium nitrate is used for the same purpose, and the salt-cake from it possesses similar and possibly superior powers to that from the sodium nitrate, owing to the fact that it is more completely a bisulphate. When common salt or sodium chloride is decomposed by oil of vitriol, either to produce hydrochloric acid or for sodium carbonate, the salt-cake resulting abounds in free hydrochloric acid, and retains, also, the excess of oil of vitriol. In either case the salt-cake is an anhydrous body, not deliquescent or hygroscopic, readily reduced to any desired degree of comminution, porous, and in all respects admirably adapted to absorb and retain ammonia and its compounds.

I have discovered and experimentally demonstrated that when gas containing ammonia or its compounds is

passed over or through a layer or mass of salt-cake properly disposed, it parts completely and at once with all its ammonia, which readily combines with the free acid of the salt-cake until it is completely saturated. The separation is so perfect that no trace of ammonia can be detected by turmeric or litmus paper in the gas after passing the salt-cake purifiers. The ammonia thus combined and removed may subsequently be separated from the salt-cake by any of the methods now in use for this purpose, leaving the soda-salt in a state fit for the soda process.

Ammonia is produced in other processes of the arts from the decomposition of organic matter containing nitrogen exhaling odors of a very offensive nature, of which impure ammonia is one of the most offensive. By the use of my process, in connection with any suitable form of condenser and without water, all the ammoniacal compounds may be removed from such offensive gases, thus abating a nuisance of no small magnitude now existing in the vicinity of many large towns. So far as I have been able to discover, my process removes from illuminating-gas in contact with the salt-cake nothing but the ammoniacal compounds, including carbonate of ammonia and ammonia sulphide, with a portion of sulpho-cyanide of ammonium, and probably, also, other compound ammoniums, the nature of which has not yet been fully determined; but all the ammoniacal compounds having been removed, the further process of purification in illuminating-gas is simplified and improved, and especially by the absence of any necessity for washing or scrubbing the gas, by the use of water and ammoniacal liquor—a process which is well understood by all gas chemists and engineers to be attended with a serious loss of illuminant power in the gas, while it involves the use of costly apparatus, and, as before mentioned, a large annual outlay for water, producing at the same time only a partial and imperfect removal of the ammonia, the residual portion of which goes forward to the consumer of gas, not only diminishing its light during burning (beyond the loss of power already experienced from the use of water in scrubbing), but producing also in its combustion a portion of nitric acid.

In the use of my invention, I prefer to bring the crude gas into contact with the salt-cake before it has passed the condenser; but this is a point which must be decided in a given case by local circumstances. If there is a reasonably prolonged flow of gas, from the hydraulic main of, for example, two or three hundred feet of large cooling mains, offering a reasonably good opportunity for the deposit of tar and naphthaline, it is better to place the boxes or other form of apparatus containing the salt-cake before the condenser. To avoid the inconvenience in this case from the deposit of tar with the ammoniacal compounds, the use of a layer of breeze or broken coke before the salt-cake is desirable in a manner familiar to all gas-engineers. This breeze will require to be changed occasionally, as it becomes coated, to prevent the arrest of flow in the gas, as indicated by the pressure-gauge.

To use the salt-cake, it requires to be broken to a coarse powder and distributed upon trays in the same manner that lime and other purifying agents are now used; only that, owing to the greater firmness and porosity of the salt-cake, it may be safely used in thicker layers than can be used with lime.

The progress and completeness in the process of removing the ammonia are readily determined by the use of turmeric test-paper, or of neutral litmus-paper, the first of which turns from yellow to brown, and the second from red to blue, as soon as the salt is saturated and the free ammoniacal salts commence to flow.

The apparatus must then be changed or recharged in the same way now in use in all gas-works for lime or iron purification. Care must be taken to avoid bringing lime in contact with the salt-cake in any stage of the process, as such contact would be attended with a loss of ammonia and a frustration of the process. The power of the salt-cake to purify gas of ammonia depends, of course, on its degree of acidity, which can be determined beforehand. Salt-cake, from the hydrochloric-acid process in the United States, contains usually about twenty (20) per cent. of free hydrochloric with some sulphuric acid. Nitric acid salt-cake here contains from twelve (12) to fifteen (15) per cent. of nitric acid, beside the acid-sodic sulphate; but it is in the power of the chemical manufacturer to prepare salt-cake of any desired degree of acidity, either by the use of an excess of oil of vitriol, forming bisulphate of sodium or potassium, as the case may be, or by arresting the heat of the furnace at a point which shall leave in the salt-cake the acidity requisite to best fit it for my process. The product of this process becomes much more valuable than the raw material used in it, each one (1) per cent. of ammonia it receives having a definite commercial value, which, in the case of guano, with ten (10) per cent. ammonia, is worth about six (6) dollars per unit at the present time in the United States. Coal contains an average of about one and a half (1½) per cent. of its weight of nitrogen; but by no means all this nitrogen reappears as ammonia after distillation. A portion of it is converted into the cyanogen compounds, and a part is probably left free. The cyanides, so far as my experiments have gone, appear to be arrested by the salt-cake, and go to the account of ammonia in the end. After my process has freed illuminating-gas from its ammoniacal impurities it may be passed through any form of condenser which may be preferred, and then it must be taken to the lime or iron purifiers for the removal of the sulphur and carbonic acid, in the manner now practised.

It is well known that the spent lime and iron oxide used in the purification of gas contain a considerable amount of ammonia, so combined that immediately on access of air the spent material commences to heat, and then exhales the odor of ammonia accompanied by offensive vapors or gases, which together have rendered the exposure of these effete products a nuisance in large towns. To avoid in part this evil the ventilation of this spent material is practised in some cases by causing a current of atmospheric air to pass downward through the purifying-boxes, after a flow of gas has been cut off, solicited by a powerful exhauster, with a view to removing this evil. If in such cases the current of air from such spent material is carried through boxes charged, as I have herein directed, with salt-cake, all the ammonia contained in the spent lime and iron, which is now a total loss, will be saved and utilized.

In the destructive distillation of animal matters for producing bone-black and the like, or specifically for the production of ammonia, in the boiling down of animal matters, as in bone boiling and rendering, in the sweating of hides, and other like processes where animal substances are employed in a greater or less state of putrefaction or chemical change, ammonia is given off, combined with other offensive vapors or gases. If these products, which are now a source of great annoyance and injury to public health, are carried, by means of a

suitable exhauster, through boxes containing salt-cake, or other acid salts, as herein described, all the ammoniacal compounds will be combined and removed. For this purpose it may be found desirable to carry such vapors first through some suitable dry condenser for the better condensation of aqueous and other vapors.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The use of salt-cake, alkaline bisulphates, or other acid salts in the removal of ammonia and its compounds in a dry-state form from illuminating-gas, or from other gases or vapors derived from the decomposition or destructive distillation of organic bodies containing nitrogen, substantially in the manner above described.

2. The use of salt-cake, alkaline bisulphates, or other acid salts in the purification of illuminating-gas, for the purpose of removing therefrom ammonia and its compounds without the use of water or ammonical liquors for washing or scrubbing, substantially as described.

3. The use of salt-cake, alkaline bisulphates, or other acid salts for disinfection of the vapors and gases resulting from the decomposition or destructive distillation of organic matters containing nitrogen for the purpose of removing therefrom any ammoniacal products they may contain, and also for the removal and saving of the ammoniacal compounds derived from the ventilation of spent lime and iron which has been used in the purification of illuminating-gas, substantially as described.

4. The use of salt-cake, alkaline bisulphates, or other acid salts for the purpose of collecting in a concentrated form as a dry salt ammonia and its compounds from illuminating-gas, or from any other mixture of gases and vapors containing the same, in the manner substantantially as hereinbefore described.

5. The process of passing illuminating and other gases and vapors through any apparatus charged with salt-cake, alkaline bisulphates, or other acid salts for the purpose of collecting and combining ammonia or its compounds when associated with such gases or vapors, substantially as above described.

BENJAMIN SILLIMAN.

Witnesses:—
GROSVENOR S. HUBBARD.
ARTEMAS H. HOLMES.

ADDRESS BY MR. JOHN PATTINSON, DELIVERED BEFORE THE NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY, OCTOBER 29, 1874.

GENTLEMEN: In commencing the duties of another session of the Newcastle Chemical Society, allow me to thank you sincerely for the great honor you have conferred upon me in electing me to the office of President.

In describing, as is usual in the inaugural address of our society, the work done during the meetings of last session, I would point out that one of the great advantages of such meetings is the opportunity they afford of discussing the various subjects brought before the society. Many interesting and useful facts are frequently elicited from our members tending to throw light on the various matters under discussion, and thought and action are thus stimulated, leading, no doubt, in many cases to further discovery and improvement, and at any rate to a more thorough knowledge of the various subjects brought under our notice. Regarded in this manner, the number of papers read during our sessions does not by any means adequately represent the amount of good work the society is accomplishing. This, then, should be borne in mind when the papers of the last session are brought under review.

After the able and suggestive inaugural address of your late president, which occupied the first evening, Mr. Berkley read an interesting paper on the "Practical Employment of Dynamite." Mr. Berkley had very successfully employed this explosive in removing what is technically known as the "bear" of a blast furnace at the works in which he is engaged. This paper, and the discussion which followed, led to another paper by Mr. John Lomas, in which the relative merits of gunpowder and dynamite were compared. The general impression left by these papers and the discussions was, I think, that although there is no doubt as to the great value of dynamite as an explosive in certain blasting operations, yet the number of instances known in which this and other preparations of nitro-glycerine had capriciously burst away from the control of man, spreading frightful devastation and death, showed that its manufacture and use are still attended with very serious danger, and that we are probably purchasing its advantages at far too great a cost of human life.

A careful and useful paper was read by Mr. Henry R. Procter on "Errors of Weighing, and their Influence on Results." The inaccuracies in the balance and its weights, and the errors arising from incorrect modes of weighing and measuring, are more frequently the cause of discrepancy in the results obtained by chemists than is usually supposed, and Mr. Procter's paper will be found very useful in placing chemists on their guard against some of these sources of error. In connection with this subject I may mention that in the rapid testings required in the laboratories of our manufactories, the influence of the differences of temperature on the volume of the standard solutions used in volumetric analysis is perhaps not sufficiently regarded. I have known a difference of 0·2 of a per cent. of soda indicated in testing a sample of soda ash with the same test acid, and this entirely owing to a difference in temperature of the test solution not greater than the difference which frequently occurs in the temperature of the air in summer and winter. The 0·2 per cent. of soda is, as you know, owing to the prevalent custom in the trade, sometimes sufficient to determine whether the soda ash is to be invoiced one per cent. of soda more or less. In all accurate tests with volumetric solutions, the solution should be standardized at a known temperature, and the coefficient of expansion of the solution by heat determined. Should a test be made with the solution at a different temperature from that at which it was standardized, a correction can then be made by adding or deducting the amount of expansion or contraction due to the difference of temperature.

I had the honor of reading, at a subsequent meeting, a paper on "the Rate at which Bleaching Powder loses its available Chlorine." The results arrived at showed that the rate of loss varied chiefly in proportion to the atmospheric temperature to which the bleaching powder was exposed, and that, contrary to the usually-received opinion, bleaching powder made to contain originally 30 or 32 per cent. of available chlorine lost its strength as rapidly as that which originally contained 36 or 37 per cent.

At the following meeting Dr. Lunge read an interesting paper on "the Various Theoretical Views of the Constitution of Bleaching Powder," in which was em-

bodied the opinions of the various continental chemists who have given their attention to the study of this apparently exceptionally-formed compound. An interesting discussion followed the reading of this and the previous paper, in which several of our members took part.

Mr. Henry R. Procter read a preliminary note at the same meeting on "A contrivance for Regulating the supply of Gas to a Burner."

The working of the Adulteration of Food Act of 1872 has for some time past attracted considerable public attention, and there can be no doubt that great injury and injustice has been done to many honest traders by the way in which its provisions have been carried out. This injury to the tradesman has also, I regret to say, been in too many instances the result of incompetency on the part of the analyst, and sometimes even to a want of judgment, and of what may be termed commercial common sense. Respectable tradesmen have had to submit to the disgrace of being convicted and fined for selling for mustard what every purchaser knows as mustard, viz., a mixture of flour and ground mustard seed; for selling, under what is merely a trade name—effervescing citrate of magnesia—a substance which was well known did not contain citrate of magnesia, and the purchaser of which would have complained bitterly if it *had* contained any; for selling tea containing a few grains of probably accidentally adhering sand, or colored on the surface with an infinitesimal amount of harmless coloring matter placed there to please the eye of the customer, but with no intention of fraud. Surely the analysts and authorities instigating these proceedings believe there is something in a name, and are determined to enforce the exact use of language in a way which it is difficult to resist. Then again, the conflicting evidence given by analysts in many cases, and the too high standards of purity by which the articles of consumption were frequently judged, showed that the necessary amount of knowledge to do their work properly was wanting in some of the persons who had received appointments under the act. Our secretary, Professor Marreco, drew attention to this subject at one of our last year's meetings, and strongly urged that in the interest alike of the buyer, the seller, and the profession, the appointment of public analyst should only be given to those persons who hold a certificate from some recognized and competent body of examiners, giving some guarantee that the holder thereof possesses the requisite medical, chemical, and microscopical knowledge. Since then a select committee of the House of Commons have inquired into the operation of the act, and in their report they make the same suggestion, and further suggest, what does not meet with such general approval, that the examining body be the authorities at the School of Chemistry at South Kensington. After all, the number of mistakes made by the analyst is fewer than might have been expected when all the circumstances are taken into consideration. When the act was first passed, but very little attention had been given to this branch of analytical chemistry, and the methods of analysis of many substances were very crude and uncertain. The limits of variation in the composition of pure articles of consumption were in many cases unknown. It is worthy of remark that the evidence taken by the select committee of the House of Commons shows that the greatest diversity of opinion prevailed even amongst those chemists who stand highest as food analysts. Dr. Voelcker and Dr. Tidy's standards for pure milk were very different from that of Mr. Wanklyn; and Dr. Voelcker and Mr. Wanklyn asserted, very positively, that the presence of foreign fat in butter could not be detected, whilst Dr. Hassall stated as positively that it could. Until our knowledge of this branch of chemical analysis is considerably increased, we are therefore likely to have cases in which differences of opinion exist, and doubtless occasionally different results of analysis obtained. The select committee, in pointing out that in some cases magistrates have declined to allow any other analysis to be taken as evidence than that of the analyst appointed to act for the district, very properly say they think that evidence from well-established analysts should be allowed to be produced for the defence, and suggest that when cases of dispute arise between the chemical authorities there should be some court of appeal to settle the disputed points. They further suggest, in the absence of further information as to any better appeal, that where the analysis of the chemist of the local authority is challenged, the sample in dispute shall be analyzed at the laboratory at Somerset House, and the decision arrived at there be regarded as final. At an important meeting of public analysts held in London in August last, to take the report of the select committee into consideration, this proposed appeal to the Somerset House laboratory was most strongly objected to, and a resolution was passed to the effect that no referee's decision in a disputed case should be accepted as final unless it be given on oath and tested by cross-examination. The meeting further objected to the suggestion that public analysts should be called upon to pass an examination at the College of Chemistry at South Kensington, or elsewhere, on the ground that such examination would lead to the exclusion of chemists of experience and to the appointments falling into the hands of young and inexperienced men. There is the further objection that undue preference would thus be given to one teaching institution to the detriment of others equally efficient. Perhaps the best and most practicable suggestion was that first made, I believe, by Mr. Allen, of Sheffield, that in order to secure a board of referees in which the analysts and the public would have confidence, it should be elected by the analysts themselves. They are best able to know the fitness of the men to occupy this position, and they would take care to select men of undisputed standing and of known special experience. The editor of the *Chemical News*, I believe, was the first to make the excellent suggestion that the Board of Examiners, to decide the fitness of candidates for the office of public analyst, should also be appointed by the public analysts themselves. A board of referees and examiners elected in this manner would secure the confidence of food analysts and the public generally, and it would be free from the objection of unfair preference for one teaching institution to the disadvantage of others.

From the evidence taken before the Select Committee there is no doubt that on the whole the effect of the act has been productive of good. A considerable check has been given to the adulteration of many articles of consumption, such as milk, tea, bread, flour, etc., and a wholesome deterrent influence has been exercised, the extent of which cannot be measured by the number of convictions which have taken place. The public mind has been set at rest regarding the sensational stories which have gone the round of the newspapers as to butter made from Thames mud, milk made from sheep's brains, iron filings in tea, etc. etc. The usefulness of the act will doubtless be very much in-

creased by the amendments it will receive during the next session. Amongst the amendments suggested in the Report, I am glad to see the one that the sale of goods to inspectors should be made compulsory on the money value of the goods being tendered. I have, myself, now great difficulty in getting hold of samples of milk which are supposed to be adulterated. The milk dealers know the inspectors, and, of course, assert they have no milk to spare when he applies for a sample. Under the present act there is no power to compel the sale.

The shortcomings of food analysts will probably soon be removed to a great extent. A vast amount of valuable information on the analysis of foods is being collected and disseminated. Already several handbooks have been published, and a number of articles have appeared in our scientific journals, on the best methods of examining various articles of consumption, so that, in a short time, we may hope to hear less of the unseemly conflicts of evidence and of unjust convictions arising from errors of analysis. Meanwhile, until such knowledge is obtained, chemists should strive to prevent their zeal from out-running their discretion. In all doubtful cases it is always wise to follow the practice of our English law, and give the prisoner the benefit of the doubt.

At the meeting above referred to, the public analysts formed themselves into a society with the proposed title of the "Association of Public Analysts," for the purpose of mutual assistance and co-operation. This organization will afford the means of carrying out the suggestions relating to the appointment of a board of examiners and referees, should the legislature see fit to adopt them. One of the most important uses of this association is, however, the opportunity which it gives of its members making known to each other the results of their various investigations, and of having the proposed methods of analysis discussed, so that accurate and uniform methods may be readily arrived at. It is very much to be regretted that the association proposes to elect its members from food analysts only. Its usefulness would be immensely increased by widening its scope so as to include analytical chemists of all classes. The desirability of having a competent tribunal to whom to appeal when conflicting analyses of various commercial products are obtained, is often felt both by commercial men and analytical chemists, and it appears to me that a board selected from an organized association, which should embrace analytical chemists of all classes, is the proper tribunal to appeal to in such cases. It is to be hoped that the association of food analysts just formed will yet see its way to somewhat alter its name and scope, and thus materially extend its usefulness both to the trading public and the profession at large.

So pressing had the question become of the formation of a court of appeal to decide disputes in commercial analysis, that our Society received a communication in May last from the chemical section of the Glasgow Philosophical Society asking us to join them in a memorial to the chemical section of the British Association, requesting that a committee of that section should be appointed to inquire into the subject of commercial analysis, and especially with reference to the analysis of potash salts and superphosphates. A special meeting of our Society was called in that month, and the matter was discussed. Many of our members were of opinion that the processes of analysis of many of the substances in which we on the Tyne are more immediately concerned, such as soda, sulphur, manganese, and copper, call equally urgently for investigation, and many instances were given of great discrepancies in the results of analysis of the same substances given by various chemists, involving, of course, the loss of large sums of money either to the buyer or the seller. It is, moreover, somewhat compromising to our analytical and commercial morality to find out, for instance, that large profits have been made by buying soda ash by one chemist's test in one district and selling by that of another chemist in another district, whilst at the same time both chemists professed to test by the same method; yet this is known to have occurred. Surely there is here gross carelessness, or worse, on one side or the other. A resolution was ultimately passed at the meeting expressing the opinion that a sub-committee of section B of the British Association should be appointed to inquire into and report upon the processes employed in commercial analyses, and more especially the analysis of copper, soda, potash, sulphur, and superphosphates, and other manures. The British Association, at their Belfast meeting, took the matter into consideration, and have appointed a committee with a grant of ten pounds to inquire into and report upon the methods at present used in the analysis of potash salts and superphosphates; so that we may hope to have a report on the matter at the next meeting of the British Association.

An important measure especially affecting the interests of manufacturers and the general public in this district, has passed the imperial legislature and become law during the last session of Parliament. I allude to the alkali act amendment bill. It was quite evident that something more was required to check the escape of deleterious gases than could be enforced by the alkali act of 1862. Vegetation in the neighborhood of chemical works was in many cases being seriously damaged, although the reports of the inspector showed that the amount of muriatic acid escaping was less than the five per cent. on the total amount evolved allowed by the act. In our own district it is sad to see how, in many places, the hedges and trees are being rapidly destroyed, and it is certain that unless a change for the better is soon produced the only trees to be seen on the banks of the Tyne in a few years will be those in the shape of posts to carry the telegraph wires. How different must have been the appearance of Newcastle in 1759, when John Wesley wrote thus of it in his journal: "I know no place in Great Britain comparable to it for pleasantness!" Dr. R. Angus Smith, the able Government Inspector under the alkali act, has for many years advocated the amendment of this measure, and it is obvious that the new act has been chiefly based upon the very numerous experiments and the suggestions made by him given in his valuable annual reports. Those who know the care, intelligence, and caution which always characterize the work and recommendations of this excellent chemist, will not doubt that the alterations, so far as he has been able to control them, are of a practicable character, and that whilst due regard is paid to the interests of the populations living in the neighborhood of chemical works, the restrictions to be imposed to prevent the escape of gases injuriously affecting animal and vegetable life are such as will not unnecessarily interfere with the growth and prosperity of valuable industries.

The first important amendment is to define the term "alkali work," so as to include works in which the treatment of copper ores with common salt is carried on. As large quantities of muriatic acid are evolved in this

process, and which no doubt in some cases is allowed to escape into the air, the placing of these works under inspection and under the same restriction as alkali works proper, will be attended with benefit.

Another marked improvement in the act is in restricting the amount of muriatic acid escaping in the chimney gases, or from any part of the works, to one-fifth of a grain per cubic foot of the gases or air leaving the works. The old mode of measuring the percentage of escape in relation to the total amount of muriatic acid evolved is still to be retained in the new act as a protection in certain cases. By allowing only the escape of a definite amount of muriatic acid per cubic foot of escaping gases, a certain state of dilution is insured, and this is a matter of great importance, for it is found that when diluted with air the destructive effects on vegetation are much lessened. The system of measuring per cubic foot is moreover simpler of execution and more easily understood, and allows of the escapes from the body of the works being determined, which could not be done by the other method of measuring by relative percentages.

The most important alteration, however, is that with reference to the escape of other noxious gases than muriatic acid. The noxious gases enumerated which are to be included in the operation of the new act are, sulphuric acid, sulphurous acid, excepting that arising from the combustion of coals, nitric acid or other noxious oxides of nitrogen, sulphuretted hydrogen, and chlorine. In one of his reports Dr. Smith gives an account of some experiments proving that the destructive power of sulphuric acid on vegetation is two or three times greater than that of muriatic acid, and about ten times greater than that of sulphurous acid. He further shows that the gases emanating from the furnaces where copper regulus is calcined contain large quantities of sulphuric acid, and attributes the well-known deleterious effect of the so-called copper smoke to this cause. Mr. Gossage had also pointed out the same thing some time before, and both gentlemen suggest that the copper smoke should be passed through a condenser to wash out the sulphuric acid before being allowed to pass into the air. This suggestion has not yet, I believe, been acted upon in any works. Those amongst us who have been acquainted with Tyneside for some years cannot but have observed how much more rapidly the hedges and trees in the neighborhood of copper smelting works have been, and are being, destroyed than they were in former years in the neighborhood of chemical works where this operation was not carried on. Possibly this more rapid destruction may be to some extent owing to the larger scale on which chemical operations are now carried on, but I am strongly inclined to think that it is chiefly owing to the sulphuric acid contained in the copper smoke, which at present is allowed to pass unhindered into the air. This state of things will probably now soon be altered. There is no attempt in the new act to define the amount of other noxious gases than muriatic acid allowed to escape per cubic foot of air. This no doubt will come afterwards, when more is known about the amounts it is possible to condense or render harmless. For the present, it is simply specified that the manufacturer shall use the best practical means of preventing their discharge into the atmosphere, or of rendering such gases harmless when discharged. The onus of proving that the best practical means are *not* used, and that an undue amount is being discharged into the atmosphere, rests with the inspector. It is obvious, therefore, that the amount of benefit the public will derive from the amended act will depend, in a great measure, on the vigilance and care with which the work of inspection is conducted, and on the manner in which its requirements are enforced. Under the judicious management of Dr. Smith we may be sure that the duties of inspection will be carefully and faithfully carried out, and that the new act will be the means of helping to secure around our manufactories that purity of the air which is so essential to the growth of vegetation and to the health and comfort of the people who are there gathered together by the requirements of the manufactures.

One effect of the act will certainly be to cause more attention to be paid by the manufacturer to the nature and amount of the gases leaving his manufactory by way of his chimneys and otherwise, and the sooner this is done the better it will be for his own gain, in some cases, judging from some of the results of the analysis of waste gases taken from the exits of vitriol chambers given by Dr. Smith. Sulphur acids were escaping, in some cases, equal to sixteen, twenty, and even twenty-seven per cent. of the total sulphuric acid capable of being formed from the sulphur burnt! I am glad to say these cases were not from the Tyne, and I should hope that it is impossible to find such instances of wicked waste in this district.

It appears to be an omission in the new act that manure works and other works where sulphuric acid is manufactured, together with lead smelting works, and copper smelting works where salt is not decomposed, are not included in its operations. It is difficult to see on what principle these works should be allowed to continue their operations without being placed under the same restrictions as to the escape of noxious gases as alkali works. When more experience, however, has been gained by the inspectors, the present tentative measure will no doubt give way to a more comprehensive one, which shall include in its operation all works liable to evolve deleterious vapors.

I would here like to call the attention of those of our members who are not engaged in the alkali manufacture, and who may therefore not have occasion to read Dr. Smith's reports, to the very great value of these documents. They are not simply a record of the testings of the amount of muriatic acid escaping from the various works, as they might have been had Dr. Smith been content to confine himself strictly to the line of his official duties; but they contain an immense number of analyses showing the amounts of other gases, such as carbonic, sulphurous, sulphuric and nitric acids, ammonia, and various organic substances found in the air near manufactories and in towns, and these are contrasted with the amounts found in country places away from manufactories and habitations; the effect of these substances in the air on the health of the people as well as upon vegetation is attempted to be shown; great numbers of analyses of rain collected from various parts of Great Britain, showing the impurities which had been washed out of the air, are also given; the work of the same kind done by other chemists on the Continent is duly recorded; in short, these reports form a complete store-house of facts relating to the condition of the air we breathe. The methods of analysis followed are also detailed, and a number of valuable suggestions are scattered throughout their pages. Dr. Smith is doing an immense amount of valuable work tending to throw light upon many of the hidden causes of disease amongst our populations, and his writings are well worth the study of all those interested in this

important question. In work of this kind it is absolutely necessary to have great numbers of analyses of air taken from a variety of places and under different circumstances before general conclusions can be drawn. The amount of work it is thus desirable to have is far more than any one man can possibly accomplish or even direct, and I am sure Dr. Smith would be glad to find that other chemists were working in the same field of research. I would advise some of our young chemists to turn their attention to this branch of analysis. They will be amply repaid for any labor and time they may bestow upon it, for the time is fast approaching when the examination of the air of a place will be frequently required to enable us to judge definitely, as Dr. Smith puts it, of its healthiness, without waiting for the evidence in the disease or death of human beings.

For some time past, the chemical manufacturer, desirous of renewing or extending his plant has, as our cousins across the water say, "been much exercised in his mind" as to which, if any, of the new processes pressed upon his attention should be adopted. This perplexity is now gradually becoming removed by the knowledge gained of their value by actual practical working. In the manufacture of bleaching powder, for example, the rival claims of the Weldon and Deacon processes have long engaged attention. So far as can be seen at present, the conclusion arrived at appears to be one which, however unpleasant to the manufacturer anxious to economize his plant capital, ought to be very gratifying to the inventors of both these processes, namely, that it is advisable to have both methods at work. In the Deacon process in its present condition, there is a large proportion of the hydrochloric acid passed through the apparatus which escapes decomposition, but which is afterwards condensed and obtained as liquid hydrochloric acid. The best way to utilize this acid for the purpose of making bleaching powder is in the Weldon apparatus. The Weldon process, thanks to the chemical and engineering skill that has been brought to bear upon it, is a decided success; and Mr. Weldon claims that of the 100,000 tons of bleaching powder now made in this country annually, 60,000 tons are made by his process. It is in use in six of the manufactories on the Tyne at present, and others are having the plant erected. The acid from three to four tons of salt produces one ton of bleaching powder by this process. Not the least of its advantages are that it very much lessens the amount of polluting matter run into our rivers and sent into the air, and that it dispenses with one of the most disagreeable operations the workman has to perform in a chemical manufactory—the cleaning out and charging of the old chlorine stills.

The Deacon process is in operation in four of the manufactories in this district. The conditions necessary for the uniform and successful working of this process are not yet fully known. The produce of bleaching powder, for instance, from one decomposer varies as much as from 10 tons to 36 tons per week, and the cause of this variation remains to be discovered, excepting that it is known that irregularity of temperature has something to do with it. The greatest difficulty to contend with is, however, that of keeping the decomposer free from leakages and the consequent production of weak bleaching powder. The gases being drawn through the apparatus by means of a pump, any fissures in the decomposer cause carbonic acid to be drawn in from the surrounding flues and conveyed to the lime chambers. Still, in spite of these drawbacks, the usual yield of bleaching powder of good strength is about one ton for every two tons of salt decomposed, and this result is obtained when the pan acid alone is used. The cost of labor, fuel, etc. is very small. The process, therefore, even in its present state, may be said to be a very successful one, and when experience and research shall have more clearly indicated the conditions requisite for uniform working, it will probably become the chief process followed in our bleaching-powder manufactories.

But little further is known of the process of making carbonate of soda directly from salt by what is called the "ammonia process." Messrs. Brunner and Mond carry it on at Northwich, but their operations, I understand, are kept so secret that nothing is known of them outside their works. Mr. Weldon, who has examined into the subject, expressed the opinion at a recent meeting of the society of arts that the process is so slow and the apparatus so expensive that it could not be economically used. It may be of interest to some of our members to know that the direct ammonia process was experimented with in Gateshead about ten years ago. The trial soon came to an end, but from causes apart, I believe, from the success or non-success of the process.

The Hargreaves process of decomposing common salt is now making considerable progress. This plant is in operation in three manufactories in Lancashire, which at present are producing from 210 to 240 tons of sulphate of soda per week by its means. The Jarrow Chemical Company are also preparing to erect plant capable of making about 100 tons of sulphate of soda per week, and it is in process of erection in other works. For the information of such of our members as are unacquainted with this process, I may explain that instead of decomposing common salt by sulphuric acid as in the old process, Mr. Hargreaves uses sulphurous acid, air, and steam for this purpose. The salt, in a suitable mechanical condition, is placed in large cast-iron cylinders, ten to fifteen feet in diameter and from ten to twelve feet high. A series of from six to ten of these are placed alongside each other and heated externally. Sulphurous acid direct from the pyrites kilns, together with air and steam, are passed through the salt in the first cylinder, then through that in the second, and so on through the whole series. A temperature of from 800 degrees to 1000 degrees Fahrenheit is found most favorable for the decomposition. It takes a fortnight or three weeks from the commencement of the operation to completely decompose the salt in the first cylinder; the salt in the other cylinders is, however, in various stages of conversion into sulphate at the same time, so that when the sulphate made in the first cylinder is drawn and the gas goes direct from the pyrites kilns to the second cylinder, the salt in this becomes completely decomposed and ready for drawing one or two days afterwards; and so on with the other cylinders. The adoption of this process will work the most radical change in the chemical manufacturer's plant, for the old familiar large leaden chambers, and the decomposing pan and furnace, which have hitherto been indispensable, will then be superseded. As the cost of the Hargreaves plant is, I understand, much about the same as that which it will supersede for the production of a given amount of sulphate of soda, the superior economy of this process must be looked for in the saving of nitrate of soda, labor, and wear and tear.

I will now briefly call your attention to a few other new processes involving chemical operations, some of which have recently been introduced in this district,

and others which are, I think, deserving of notice because they are likely to affect the interests of the manufactures which are carried on in our midst.

Of late years chemists and manufacturers have devoted much attention to the utilization of what have usually been considered waste products. The Weldon process already alluded to, in which peroxide of manganese is reproduced from the hitherto waste chloride of manganese liquors, is an instance of the success which has been achieved in this direction. This is also admirably illustrated in the treatment of the cupreous iron pyrites, now so largely imported from Spain and Portugal, by which almost every constituent of this mineral is now utilized and made a source of profit to the manufacturer. When the sulphuric acid maker has extracted the most of the sulphur, the burnt ore is handed over to the copper extractor, who not only separates the copper it contains, but, at the same time, so perfectly removes the remaining sulphur that the residue, consisting chiefly of peroxide of iron, is suitable for, and is now largely used in, various iron-making processes. It is well known that the original pyrites contain small quantities of silver—from half an ounce to one ounce per ton—and this is, also, now in many instances, separately extracted and sold. It is found that the most of the silver is obtained in solution along with the copper after the burnt pyrites has been roasted along with common salt and subsequent lixiviation with water. Mr. F. Claudet, a few years ago, patented a process for obtaining the silver from these solutions by precipitating it with an alkaline iodide, and this process is, I believe, successfully at work in some of the copper-extracting works in Lancashire. Within about the last twelve months one of our members, Mr. Thomas Gibb, of the St. Bede Metal and Chemical Works, has devised an ingenious method of extracting the silver from these solutions, which is now in successful practical operation at these works, and it is to this process that I now wish to direct your attention. Mr. Gibb's method of separation is based on the fact, I believe, first discovered by him, that when sulphuretted hydrogen diluted with common air is passed through a cupreous solution containing small quantities of silver, the silver is precipitated first, or, at any rate that the most of the silver is precipitated as sulphide with a relatively small proportion of the copper. For the particulars given in the following description of this process I am indebted to Mr. Gibb. Sulphuretted hydrogen is generated by the action of dilute hydrochloric acid on soda waste, and drawn from the generating tanks, in admixture with common air, by a blowing engine which forces the mixture into the copper solutions. This is continued until about six per cent. of the copper in the liquors is precipitated, when it is found that the solutions which usually contain about 20 ozs. of silver per ton of copper before the action of sulphuretted hydrogen, are reduced to 3 ozs. of silver per ton of copper on the average, and the mixed sulphides of copper and silver precipitated contain about 200 ozs. of silver per ton of copper. The sulphide precipitate is washed and calcined at a low temperature. The silver becomes soluble in common salt solution, the precipitate, although washed, retaining chlorides sufficient to change the sulphide of silver into chloride in the calcination. A part of the sulphide of copper is changed to sulphate, and the remainder to oxide, by the calcination. The sulphate of copper is washed out with water in wooden tubs, and the chloride of silver, with some chloride of copper, is subsequently dissolved out by strong hot brine. The sulphate of copper solution first washed out contains only about one ounce, and the oxide of copper remaining after dissolving out the chloride of silver 4 or 5 ozs. of silver per ton of copper. The former is precipitated with the ordinary copper liquors in the usual manner, and the latter smelted with the ordinary copper precipitate. The solution of chlorides of silver and copper in common salt is mixed with milk of lime to decompose the metallic chlorides and the chloride of calcium produced is washed from the precipitated oxides. These oxides are treated with dilute sulphuric acid, which dissolves the oxide of copper, leaving the silver. The residue, which contains about 10 per cent. of silver as chloride with sulphates of lime and lead, after the sulphate of copper has been washed from it, is dried and sold to silver smelters. Fully half an ounce of silver per ton of burnt ore is recovered, and although the operations just described appear somewhat numerous and troublesome, yet the total cost of recovery is not more than 1*s.* 6*d.* per oz. of silver. During this year, an amount of residue containing 16,000 ozs. of silver has already been extracted at the Bede Metal Works by this process.

Another novelty introduced in our district, and which I think is deserving of the attention of our members, is the new form of condenser recently patented by Messrs. Newall and Bowman of the Washington Chemical Works, and which these gentlemen have in use and are now experimenting with for the condensation of hydrochloric acid in their works at Washington. In this condenser condensation is effected by passing the acid gas through one or more stone cisterns, about six feet square and two feet deep, into each of which water is entering through a small orifice of about 0·06 of an inch diameter, under a pressure of about 40 lbs. The fine stream of water is projected by this pressure with great force against a small disk, and is thus dashed into fine spray, which fills the whole of the vessel, and meeting with the hydrochloric acid gas, condenses it, forming liquid hydrochloric acid of the strength usually of 28 degrees of Twaddell's hydrometer. There is a considerable amount of heat developed by the condensation of the gas, and the vapor of water laden with hydrochloric acid after leaving the vessels in which the spray producers are placed is at present passed into a small condenser of the ordinary construction (much too small to do the whole work of condensation itself), where the vapor is cooled and perfectly condensed. In places where an ordinary condenser is not already in existence to be thus utilized it is proposed to place a series of cooling pipes between the spray producer vessels in order to cool the vapor. I am glad to be able to say that Mr. Bowman intends to give the society a paper on the construction of this new condenser and the results obtained by its use.

It appears to me that these spray producers may be used with great advantage in washing and purifying the smoke and gases from copper works, outlets of sulphuric acid chambers, manure works, and in many other cases where noxious vapors are sent into the air. With such an apparatus the draught of the chimney need not be interfered with, and what is of great importance for the effectual removal of condensable gases, every particle of the gases would be brought into contact with water. I would recommend that experiments in this direction should be made.

The spray producer may also probably be found of use in the purification of lighting gas as a substitute for the scrubber. An American engineer, Mr. B. E.

Chollar, of St. Louis, patented, in 1872, an apparatus for this purpose, in which spray was produced by injecting water into a vessel through which the gas passed, by means of a jet of the gas under process of manufacture compressed to about 10 lbs. on the inch by a suitable compressor. More recently still, two French engineers, MM. Pelouze and Audouin, have patented a similar apparatus for the same purpose. Messrs. Newall and Bowman's water spray is, however, produced by much simpler means, and will probably be found to be as effective for this purpose.

A discovery has recently been made in iron metallurgy which is likely to be of very great importance to the iron manufacturers of this and all other districts where the iron produced contains considerable quantities of phosphorus. It has been considered an axiom amongst steel makers that it is impossible to produce good workable steel if the amount of phosphorus it contains exceeds somewhere about five-hundreths of a per cent. of the steel. As it is well known that neither the Bessemer process nor the Siemens-Martin process of steel making eliminates the phosphorus from the iron under treatment, it has hitherto been found necessary to use only such pig iron for these processes as was nearly quite free from this ingredient. The attention of chemists and metallurgists has therefore for long been directed to discover a method for effectually and economically removing phosphorus from its combination with pig iron, but hitherto no process better than the old puddling process has been devised, and this does not remove the phosphorus so thoroughly as to make the iron sufficiently free from it to fit it for the requirements of the steel maker. It has now been discovered that much more phosphorus may be left in the steel without injury to the product than has hitherto been thought possible, provided the amount of carbon be at the same time reduced; in other words, the less carbon there remains the more phosphorus may be left in the steel. Thus a steel of good workable quality suitable for making rails is produced, which contains 0·30 of a per cent. of phosphorus, if only 0·15 per cent. of carbon be present at the same time. It is difficult to ascertain to whom the merit of this discovery is due. It appears that the late Mr. Matthiessen years ago held the principle upon which it is based, and Mr. Frederic J. Slade, of the New Jersey Steel Company, seems to have discovered the same principle and carried it into practice in the beginning of 1870. It has, however, recently been brought into public notice by the publication of the researches and experiments of M. Tessié du Motay and of M. Euverte of the Terre Noire Steel Works in France, and it was at these works that the steel of the composition just mentioned was produced. The chief credit of making the principle known, and showing how it can be carried into practice, may therefore be claimed by them. When the pig iron used in the Bessemer process has been decarbonized by the action of the air a certain amount of oxygen remains in the iron either as oxide or in some other condition, and it is necessary to remove this and, in this process as well as in the Siemens-Martin process, to add substances to convert the iron into steel. Spiegeleisen, a substance containing about ten per cent. of manganese and five per cent. of carbon, is at present used for this purpose. It is found, however, that, when spiegeleisen of this quality is used in the necessary amount to convert the iron into steel, it introduces too large a proportion of carbon to admit of a workable steel being produced from iron containing more than a few hundredths of a per cent. of phosphorus. When, therefore, "phosphorus steel," as it is called, is to be produced, it is necessary to use for the last-named process a material containing a smaller amount of carbon in relation to its manganese than spiegeleisen contains, and such a material is found in ferro-manganese, which can be obtained containing from 40 to 70 per cent. of metallic manganese and about 5 per cent. of carbon. This material is, however, very expensive, the present price being about 1*s.* 6*d.* per lb., and although only about two per cent. of it is required in the steel, yet this amount adds about £3 7*s.* 6*d.* per ton to the cost of the steel. At Terre Noire, however, they find that it answers their purpose to use this expensive material. No doubt means will soon be found to produce good ferro-manganese at much less cost. When this is the case, there is every reason to believe that Cleveland puddled bar may be largely used in the manufacture of steel. There is no difficulty in producing puddled bar from Cleveland pig iron containing only 0·2 or 0·3 per cent. of phosphorus, especially if the revolving puddling furnace is used, one form of which (Crampton's) promises now to be commercially successful.

At the present time there are several attempts being made to produce iron and steel directly from the ore without the intervention of the blast furnace. Besides the Siemens process, which was described by Mr. Siemens in a paper read before the Chemical Society in London in the beginning of last year, there are two or three being tried, which are based on the principle employed many years ago by Clay, Renton, Chenot, and others, which consists in reducing the iron in the ore to the metallic state by heating it with carbonaceous matter in close retorts, and afterwards heating the reduced ore in reverberatory furnaces to melt out the slag and to weld the particles of iron together. The process of this kind which is attracting most attention at present is that of Mr. Blair, of Pittsburg. He heats a mixture of iron ore and charcoal in vertical tubes forty feet in height and three feet in diameter. The upper part of this tube is heated externally by gas generated in gas producers, and internally by the combustion of the carbonic oxide arising from the action of the charcoal on the iron ore, whilst the lower part is cooled by incasing it in a water jacket. The iron which is reduced to the metallic state in the upper part of the tube is thus cooled down in an atmosphere of carbonic oxide in the lower part, so that when it reaches the bottom of the tube it may be removed in the air without fear of re-oxidation. The materials are fed in at the top and withdrawn at the bottom continuously. The metallic sponge thus produced is then pressed into lumps by hydraulic pressure, and used for the making of steel in the Siemens-Martin process, instead of wrought iron. The process has been at work for some time at the Glenwood Iron Works, Pittsburg, and Mr. Blair claims that there is a very considerable saving in the cost of production of steel from his iron sponge as compared with the use of wrought iron. With very rich iron ores processes of this kind may probably be economical if a well-planned apparatus is used; but it is very doubtful if this would be the case with poor and siliceous ores, owing to the waste of iron which would occur in smelting out the earthy matters. Mr. Blair's process is not yet removed from the region of experiment, and the progress it makes will be watched with interest by all iron and steel makers.

In conclusion, gentlemen, let me point out that to enable our society to prosper as it should do, and to be

of that service to all its members that it is capable of being, it is necessary that our members should take a more active interest in it by the preparation of papers, and by attendance at its meetings for the discussion of these papers. The amount of work done last session is certainly much less than may be expected from a society numbering about one hundred members, most of whom are practically engaged in working various chemical processes in our manufactories. There are a great number of subjects upon which much information is needed, and which I am sure many of our members can supply. Details of the practical working of the Weldon, Deacon, and Hargreaves processes are much wanted; and if those of our members who have had experience of these details would place them on record by preparing papers, they would not only further the interests of our society, but they themselves would probably profit by the discussions which would follow. To our younger members I would say that the knowledge and mastery of a subject which the preparation of a paper necessarily gives, abundantly repays the writer for all the labor and time he may have bestowed upon it. It is not essential that papers should contain accounts of brilliant new discoveries. Descriptions of experimental workings of processes, notices of unexplained reactions, or notes on modifications of analytical processes, would form excellent subjects for papers. There is much to be learned from accounts of processes which have proved to be unsuccessful. They are of great benefit, if only to prevent others from going over the same ground, and we should be glad to have papers of this description. I trust that in the session we are now commencing, every member will do all he can to promote the prosperity and usefulness of our society.

Mr. Glover proposed that the thanks of the meeting be given to Mr. Pattinson for his very comprehensive and lucid address. The President's remarks as to the operation and effect of the food adulteration acts came with great force from him. It was quite evident to those who read the current literature of the day, that great injustice had often been done in the administration of those acts; and some such tribunal as Mr. Pattinson mentioned was evidently required to give weight to those analytical chemists who had to determine what was and what was not adulteration. He had also mentioned a matter which came home to most of them, in the extension of the alkali acts. There was no doubt that that subject was one which affected the prosperity of this district to a large extent. The proposition to test the waste gases from the chimney was good, and at once went to the root of the matter, inasmuch as it determined what should be really sent into the atmosphere —not so much what appeared to be the percentage of loss or adulteration, but what really went into the atmosphere. Dr. Smith had the objection laid before him that in many cases the manufacturers so conduct their operations that perhaps one chimney was engaged in conveying into the atmosphere the products of decomposition of the decomposing apparatus, while the great bulk of the gases were sent into the atmosphere from other chimneys; therefore, although from that chimney that was so loaded with the products from the decomposing processes, it might appear to contain a large amount, yet the total quantity sent into the atmosphere from all the chimneys of the works would really amount to less than the defined quantity. Dr. Smith, of course, met that by saying he had no objection even if the manufacturer turned common air into his chimney; what he wished to enforce upon manufacturers was, that the amount of gases going into the air should be in a certain state of dilution. He instanced the well-known fact that any man may take prussic acid in a diluted form, but he could not take it in a very concentrated form; and he applied the same reasoning to sending gases into the atmosphere. Well, there was a great deal in that reasoning, and this appeared to satisfy her majesty's inspector; and it remained for them all now to endeavor at any rate, if they did send gases into the chimney, to see that they were in such a diluted form that they should comply with the requirements of the act. He thought the thing could be managed quite well in this district, and he believed a great many chimneys in this district were already doing so. With regard to the supposed connection between the death-rate of Newcastle and emanations from chemical works, a good deal had been said; and the public generally ran away with the idea that there was a direct connection between the high death-rate of Newcastle and chemical works; but he thought such a deduction was unphilosophical. We had had the highest death-rate in Newcastle during the last year, and an appeal to the records kept in the district would show that the prevailing winds had really been carrying the gases from the chemical works from Newcastle. He believed that in Dr. Smith's report this matter was put in a still clearer light, although Dr. Smith did not mention it; for therein he showed that the death-rate of Byker was the lowest in the district; and they all knew that from the position of Byker, blow almost which way the wind would, it received smoke from the chemical works, and he drew a decided conclusion from this. He thought that the putting the public on a wrong scent was apt to do mischief. The fact was, that any one who had examined into the sources of the death-rate of Newcastle, saw that they sprung from facts which were not at all connected with emanations from chemical works. They had to look to some other source, such as, for example, drainage, overcrowding, etc., especially when the death-rate was connected with diseases which spring from such causes. He thought it fair to mention this. It was a subject which he thought might fairly come within the scope of that society to discuss the causes of the high death-rate of Newcastle. He was not positive, but believed it was a fact that the death-rate of Hexham was quite equal to that of Newcastle, and they knew there were no chemical works connected with Hexham. He mentioned these as connected facts; but he believed that if they were connected in a scientific manner they would remove the opprobrium from chemical works, which had quite enough to bear without being saddled with the high death-rate of Newcastle.

Mr. Clapham begged to second the vote of thanks to Mr. Pattinson for his address; after the very able remarks of Mr. Glover he thought it would hardly be necessary on his part to do more than fully endorse all that Mr. Glover had said on the subject.

Mr. Berkley said that Mr. Glover being such an extensive chemical manufacturer, he had been very glad to hear his remarks on the subject of emanations from chemical works; but he was quite certain that if they were conducive to human longevity they were not conducive to the longevity of vegetable life. He thought the gardens of this district bore very strong evidence of the fact. They talked of "black Wallsend;" but he recollected when it was a very pretty place; and as to John Wesley's description, he would scarcely know the place if he came back to it.

Dr. Lunge asked to be allowed to supplement this

by a fact. Mr. Alderman Imeary had taken the trouble of going very minutely into the death-rate of South Shields, which was credited with having an abundance of chemical gases in its atmosphere. He had found that, according to the official returns, the death-rate amounted to only 22 or 23 per thousand per annum; and he adduced certain reasons which proved that in reality it was rather below that figure. Now, that would be considered a very satisfactory state of matters for a town of the size of South Shields, even if it were not a manufacturing place. He thought that this alone proved that chemical works had very little to do with the death-rate.

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS.

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Berichte der Deutschen Chemischen Gesellschaft zu Berlin.

No. 9, 1874.

On the crystalline form and the molecular modifications of **selenium**.—C. Rammelsberg.—Author finds that sulphur and selenium are isomorphous. When selenium is melted and then allowed to congeal, it yields amorphous selenium, which is converted into gray, granular, metallic selenium at 90°, the process being accompanied by an evolution of heat. These two forms of selenium differ from each other very markedly. A concentrated solution of potassic or sodic selenide deposits lamellar, black, microscopic crystals of selenium.

Investigations on the constitution of **nitrolic acids**.—Victor Meyer and J. Locker.—Meyer formerly proposed the formula $CH_3—CO—NO_2.NH$ for ethylnitrolic acid; and he supposed it to be formed from nitroethan $CH_3—CH_2—NO_2$, by oxidation to $CH_3—CO—NO_2$, and subsequent addition of NH. If this view is correct, then nitrolic acid can only be formed from the nitro-derivatives of primary alcohol radicals. Investigations were made with normal nitropropan $CH_3—CH_2—CH_2—NO_2$, and pseudo-nitropropan $CH_3—CHNO_2—CH_3$. It was found that the former yielded an acid, while the latter did not. The propylnitrolic acid, thus obtained, resembles very closely ethylnitrolic acid, which has been studied carefully. The action of nitrous acid on pseudo-nitropropan gave a substance which is obtained from its solutions as a white powder or as small white crystals. In solution it is always blue.

On the precipitation of **alumina by means of borax**.—Carl Jehn.—When a solution containing alum is treated with borax solution, alumina is precipitated quantitatively.

Investigations on the **volume constitution** of solid bodies.—H. Schroeder.—Author finds that the volumes of the components of every compound stand in proportion of simple whole numbers to each other. He explains this by supposing that bodies only combine in volumes that are simple multiples of each other. Examples are given which illustrate this principle.

On **losses of nitric acid** in the manufacture of sulphuric acid.—W. Hasenbach.—The losses are of three kinds: 1. A portion is held back by the crystals of the leaden chamber. 2. A portion passes off into the air on account of faulty absorption. 3. Possibly a portion is reduced to nitrous oxide and nitrogen.

Concerning **bleaching-powder**.—C. Schorlemmer.—When bleaching-powder is distilled with dilute sulphuric acid, the distillate always contains hypochlorous acid.

Communications from the University Laboratory at Würzburg.—J. Wislecenus.—

XI. These investigations have for their object the explanation of the **syntheses** by means of **ethyl acetate**. Author starts with acetyl ethyl acetate $CH_3—CO—CH_2—CO—OC_2H_5$. This is dissolved either in anhydrous ether or benzol, and treated with sodium. It takes up just one atom of the metal and no more, forming the compound $CH_3.CO.CHNa.CO.OC_2H_5$. In this latter compound the metal atom can be replaced by organic residues, substances being formed of the general formula—

$$\begin{array}{l} CH_3 \\ | \\ CO \\ | \\ CHX \\ | \\ CO.O.C_2H_5; \end{array}$$

in which X represents a monatomic residue, or an equivalent part of a polyatomic residue. According to this principle, the ethyl, benzyl, benzoyl, and other derivatives were prepared. In the products of these first syntheses a second hydrogen atom can be replaced by sodium. The ethyl compound yields a product—

$$CH_3.CO.C(C_2H_5)Na.CO.O.C_2H_5.$$

In this latter the metal atom may again be replaced by organic residues. If the ethyl is the substituting residue, the product is—

$$CH_3.CO.C(C_2H_5)_2.CO.O.C_2H_5.$$

Of course in this way two different residues may be introduced, and thus compounds obtained of the general formula—

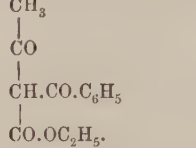
$$\begin{array}{l} CH_3 \\ | \\ CO \\ | \\ CXY \\ | \\ CO.OC_2H_5. \end{array}$$

Acetyl ethyl acetate and sodium ethylate give the sodium compound of the former and ethyl alcohol. Sodium ethylate acts in the same way upon the ethyl

compound of acetyl ethyl acetate, viz., the sodium compound of the latter is formed, and also ethyl alcohol.

XII. It was shown that pure acetyl ethyl acetate, when heated to 230–250°, is resolved into ethyl acetate and dehydracetic acid.

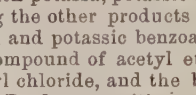
XIII. The sodium compound of acetyl ethyl acetate was treated with benzoyl chloride, and the benzoyl compound thus obtained, the formula of which is—



When this is treated with potassa, potassic carbonate is precipitated, and among the other products are methylphenyl ketone, acetone, and potassic benzoate.

XIV. The sodium compound of acetyl ethyl acetate was treated with benzyl chloride, and the benzyl compound thus obtained. By decomposition with potassa this yielded methyl-phenethyl ketone.

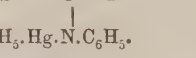
XV. Phenyl xanthogenamide takes up mercuric oxide easily when gently heated with it. The resulting compound crystallizes readily, and has the formula—



On a new method of preparation of **durole.**—Paul Jaunasch.—The method consists in employing dibromdimethylbenzol instead of bromtrimethylbenzol.

On **ethyldiacetic acid.**—E. Lippmann.—Author prepared this acid in the same manner as Mixter, six years ago.

On an addition-product of **bromacetic acid with methyl sulphide** and its derivatives.—Crum Brown and E. A. Letts.—Bromacetic acid and methyl sulphide act readily upon each other, forming a new compound, methyl-thetin hydrobromate—



On the oxidation of **butyric, caproic, succinic, and oxalic acids by nitric acid.**—E. Erlenmeyer, O. Sigel, and L. Belli.—Normal butyric acid yields succinic acid; normal caproic acid yields succinic and acetic acids. Succinic acid itself yields carbonic acid and water.

On **amido caprylic acid** and **hydroxycaprylic acid.**—E. Erlenmeyer and O. Sigel.—The first acid was prepared in considerable quantity by the reaction of œnanthol-ammonia, prussic acid, and chlorhydric acid. The hydroxy-acid was formed in small quantity as a by-product.

On the preparation of **methyl ether.**—E. Erlenmeyer and A. Kriechbaumer.—The following method yields 57–70 per cent. ether from methyl alcohol. A mixture of 1·3 parts methyl alcohol and 2 parts sulphuric acid is heated gradually to 140°. At 110° the evolution of the required gas begins. This is conducted into sulphuric acid that is surrounded by cold water. One vol. sulphuric acid absorbs 600 vols. methyl ether. This solution may be kept any length of time, and may be transported in carboys. When the ether is required, it is only necessary to let 1 part by weight of this solution drop gradually into 1 part by weight of water, and to collect the gas, which is then evolved regularly.

On some salts of **boracic acid.**—Rudolf Benedikt.—Although boracic acid is considered as tribasic, there is only one tribasic salt known, viz., a magnesium salt obtained by Rammelsberg. The author's attempts to obtain other tribasic salts were not successful.

On the **sulphur compounds of the isomeric phtalic acids.**—Josef Schreder.—Thiophtalic acid.—Phtalchloride was first treated with phenol and the phenyl ether thus obtained. This was then treated with KHS in alcoholic solution. There was finally obtained the anhydride of thiophtalic acid $C_6H_4\begin{matrix}CO\\CO\end{matrix}\!\!>\!S$. Terephtalchloride, treated in the manner above described, yielded the thio-acid $C_6H_4\begin{matrix}COSH\\COSH\end{matrix}$ instead of the anhydride. Isophtalic acid seems to conduct itself like its two isomeres.

On **nitrobutan.**—Eugen Demole.—Nitrobutan was prepared from isobutyl iodide according to the usual method. Its formula is $C_4H_9NO_2$. Iron and acetic acid convert nitrobutan into butylamine.

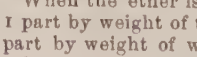
Investigations on substitution in **nitrated fatty bodies.**—Victor Meyer and J. Tschermak.—It has previously been shown that, whereas monobromnitroethan, like nitroethan itself, is an acid, dibromethan is a neutral body. This difference is easily explained by the following formulas:—

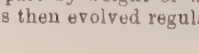
Nitroethan; weak acid.	Monobromnitroethan; stronger acid.	Dibromnitroethan; neutral body.

It will be seen that the first two substances contain hydrogen combined with carbon which is also in combination with the nitro-group, whereas the last contains no such hydrogen. The first two have acid properties, the last has not. If this explanation is correct, then there may be foretold a characteristic difference between primary and secondary nitro-bodies. It is plain that a secondary nitro-body, as, for instance, pseudonitropropan, must entirely lose its acid properties by the entrance of one bromine atom, whereas a primary nitro-body, as nitroethan, will have its acid properties increased by the entrance of one bromine-atom, and will lose these properties entirely by the entrance of two bromine atoms. Thus normal and pseudonitropropan are both weak acids. But, according to the above principle, their monobrom-derivatives must exhibit entirely different properties, as will be seen from the following:—

Brom-pseudonitropropan; neutral.		Brom-nitropropan; acid.
	and	

Further, it has been found that when bromine is allowed to act upon an aqueous solution of potassic nitroethan, three products are obtained, viz., nitroethan, monobrom- and dibromethan. This is easily understood when it is remembered that bromine does not act upon nitroethan alone, but easily upon its potassium derivative. The three following equations make this clear:—





$$C_2H_3\begin{cases}Br\\K\\NO_2\end{cases}+Br_2=KBr+C_2H_3\begin{cases}Br\\Br\\NO_2.\end{cases}$$

According to this all primary nitro-hydrocarbons will conduct themselves like nitroethan; *i. e.*, by the action of bromine upon their potassium salts, they will yield the nitro-body together with a mono- and a dibrom-product. The secondary nitro-compound will only yield a single product, viz., a monobrom-compound.

The interesting principles thus laid down were found to hold good in connection with the brom-substitution products of the two nitropropans.

Communications from the laboratory at Greifswald.—H. Limpricht.—An examination of the products of the action of **fuming sulphuric acid upon paratoluidine.**

Most convenient method for the preparation of **cuprous chloride.**—Karl Henmann.—Consists in mixing 14·2 parts powdered cupric oxide with 7 parts ordinary zinc-dust, and adding this mixture gradually to crude concentrated chlorhydric acid. The solution thus obtained is treated with water, and the chloride then separates as a snow-white crystalline powder. The formation is explained by the following equation:—

$$2CuO+Zn+4HCl=Cu_2Cl_2+ZnCl_2+2H_2O.$$

Desulphurization of the **mustard-oils.**—W. Weith.—Upholding author's previous statements which have been doubted by Hofmann.

On a new constituent of **Sumatra benzol-resin.**—Albert Theegarten.—The new constituent is a hydrocarbon, probably of the series C_nH_{2n-8}, identical with styrol prepared from storax.

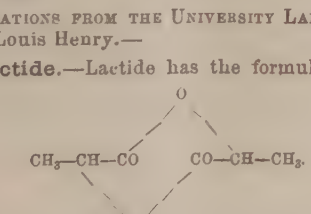
No. 10.

Change of **cinnabar by light.**—Karl Henmann.—Cinnabar prepared in the best way is very sensitive to light, particularly when placed under alkaline liquids. Its color changes from red to black. No metallic mercury separates, but the sulphide passes into another modification.

Desulphurization of cinnabar at a low temperature.—Karl Heumann.—When cinnabar and copper foil are placed together in water and the latter boiled, the sulphur passes from the mercury to the copper. The same decomposition takes place when zinc-dust is used instead of copper.

Communications from the University Laboratory at Louvain.—Louis Henry.—

I. On **lactide.**—Lactide has the formula $C_6H_8O_4=$



This was proved by determining the specific gravity of the vapor.

II. On the addition-products of **hypobromic acid with allyl** compounds, and on the triderivatives of glycerin in general.—Three chlorobromhydrines of glycerine are known. The first, $CH_2Cl—CH.OH—CH_2Br$, is obtained by the addition of HBr or HCl to epichlor- or epibromhydrine. The second, $CH_2Cl—CHBr—CH_2OH$, is obtained by the addition of (OH)Cl to allyl bromide. The third, $CH_2Br—CHCl—CH_2OH$, is produced when (OH)Br acts upon allyl chloride.

III. On **chlorobrompropionic acid.**—Two of the four possible acids of this name were obtained from the last two varieties of glycerinchlorobromhydrines above mentioned.

IV. On the preparation of **hydrocarbons containing acetylene.**—The method proposed consists in treating the aldehydes with PCl_5 or PCl_3Br_2, thus producing their bichlor- or bibrom-derivatives. From these derivatives then HCl or HBr is to be abstracted by means of caustic potassa. In this way valeric aldehyde was converted into isopropylacetylene—

$$\begin{matrix}CH_3\\CH_3\end{matrix}\!\!>\!CH—C\equiv CH.$$

V. On the radical **propargyl.**—Propargyl is pentavalent, and yields three classes of compounds—$(C_3H_3)X$, $(C_3H_3)X_3$, and $(C_3H_3)X_5$. The bromides corresponding to these three general formulas were prepared and examined. The formulas are—

$$\begin{matrix}CH_2Br\\|\\C\\|\\CH\end{matrix}\qquad\begin{matrix}CH_2Br\\|\\CBr\\\|\\CHBr\end{matrix}\qquad\begin{matrix}CH_2Br\\|\\CBr_2\\|\\CHBr_2.\end{matrix}$$

VI. On the **alcohol derivatives of chloral.**—Chloral combines with all hydroxyl-compounds with alcoholic function, and may hence be considered as a reagent for compounds with alcohol nature. The reaction takes place always in the same manner. An alcohol molecule attaches itself to each aldehyde group —CHO of the chloral. The product may be represented by the formula—

$$CCl_3—CH\!<\!\begin{matrix}O(X)\\OH.\end{matrix}$$

Potassic iodide from cupric iodide.—Georg Langbein.—Cupric iodide is suspended in water, acidified with a few drops of chlorhydric acid, and sulphuretted hydrogen then conducted into the liquid until all the iodide is converted into iodhydric acid and cupric sulphide. The solution of iodhydric acid thus obtained is treated with potassic carbonate and evaporated to crystallization.

On **tricyanhydric acid,** a compound polymeric with prussic acid.—R. Wippermann.—This new body is formed when prussic acid either anhydrous or in aqueous solution is left in contact with substances which have the power to neutralize acids. The metamorphosis is accompanied by a strong evolution of heat. The new product crystallizes and has the same composition as cyanhydric acid. Its constitution is probably

$$\begin{matrix}&&NH_2\\&&|\\N\equiv C—&C&—C\equiv N.\\&&|\\&&H\end{matrix}$$

On the existence of **hydrates** in the aqueous solutions of acids.—Julius Thomsen.—Berthelot has attempted to show that when the acids are mixed with water certain hydrates are formed. The author denies the existence of these hydrates, and shows that the experiments thus far made do not justify the supposition that they exist.

On **guanamine.**—M. Neucki.—This substance was obtained by heating guanidin acetate.

On **sulphourea-ethyl oxalate.**—M. Neucki.—Sulphourea and ethyl oxalate combine directly, forming a product $(CSN_2H_4)_2C_2O_2(C_2H_5O)_2$ which crystallizes well. When heated it separates into its components.

On **laurostearine.**—Hugo Schiff.—By recalculating the results of older analyses it is found that laurostearine, like the other known fats, is a glycerine derivative, viz., trilaurylglycerine, $C_3H_5(O.C_{12}H_{23}O)_3$.

On **chrysoquinone.**—C. Graebe.—When heated with soda-lime, chrysoquinone yields a hydrocarbon of the formula $C_{16}H_{12}$. The constitution of this hydrocarbon has not yet been established, though, from the striking analogy exhibited between it and phenanthrene, it seems probable that it may bear the same relation to phenylnaphthalene as phenanthrene bears to diphenyl.

On the **nitrolic acids** and their isomeres.—Victor Meyer and J. Locker.—Propylnitrolic acid, like ethylnitrolic acid, undergoes spontaneous decomposition, the products being propionic acid, nitrogen, and nitrous acid. When nitrous acid acts upon pseudonitropropan, a product is obtained which is isomeric with propylnitrolic acid. This is called propyl-pseudonitrole. It differs in all its properties very markedly from propylnitrolic acid. Its constitution has not yet been established.

Concerning the constitution of **nitrobutan.**—Eugen Demole.—Nitrobutan from iodisobutyl yields a nitrolic acid like the other primary nitro-bodies. Sulphuric acid decomposes this acid, yielding isobutyric acid. Further, the action of bromine upon the potassium compound of nitrobutan causes the formation of nitrobutan and its monobrom and dibrom derivatives. These facts, taken together, prove that nitrobutan is a primary nitrobody, and has the constitution already ascribed to it, viz.:—

$$\begin{matrix} CH_3\,CH_3 \\ \diagdown\ \ \ \ \\ \ \ CH \\ \ \ \ \ | \\ \ \ CH_2.NO_2. \end{matrix}$$

Communications from the Göttingen University Laboratory.—H. Hübner.—

1. On **thihydrobenzoic, dithiobenzoic,** and **bromthiohydrobenzoic acids.**—Fr. Frerichs.—This is a repetition of a former investigation, pure sulphobenzoic acid being now employed as the starting-point.

2. On **metabromtoluol.**—E. A. Grete.—From metabromtoluol only one sulpho-acid is formed.

3. On **α-parachlortoluolsulphonic acid** and **nitro- and amidoparachlortoluols.**—A. Engelbrecht.—When nitric acid acts upon crystallized parachlortoluol, two nitro-compounds are formed.

4. Concerning **lanthanum** and **didymium.**—Fr. Frerichs.—Two methods of separation were employed. 1. The mixture of oxides was heated in a current of chlorine. They are thus converted into oxychlorides, $La_3O_2Cl_2$ and $Di_3O_2Cl_2$. These oxychlorides conduct themselves differently towards water. The former remains unchanged, the latter is converted into $DiCl_2 + Di(OH)_2$. But if lanthanum oxychloride is present in a solution of didymium chloride, the following decomposition takes place:—

$$La_3O_2Cl_2 + 2DiCl_2 + 2H_2O = 3LaCl_2 + 2Di(OH)_2.$$

Hence, if the proper proportions of the two substances are present in a mixture, it is thus possible to obtain pure lanthanum chloride in solution. 2. The mixture of oxides is dissolved in nitric acid, and then sulphuric acid, in not quite sufficient quantity to convert all the lanthanum into the sulphate is added. The solution is now evaporated, and gently ignited, by which means the nitrate is decomposed, and thus rendered insoluble. The sulphate can then be extracted with water in a pure state. Or a little more sulphuric acid than is necessary to convert all the lanthanum into sulphate is added in the first place. On now performing the above operations the insoluble portion of the residue is pure didymium oxide.

A number of compounds of the two metals were prepared and examined.

5. Separation of **barium from strontium, calcium, and magnesium by means of neutral potassic chromate.**—Fr. Frerichs.—The mixtures are dissolved in water, and to the solution sodic acetate and an excess of acetic acid added. Barium may be precipitated quantitatively from the solutions by means of potassic chromate. Analyses are given in proof of the value of the method.

Aluminium-palladium chloride.—A. Welkow.—The compound was formed in solution of aluminium in chlorhydric acid, to which was added palladium chloride. The formula is $AlPdCl_5 + 10H_2O$, or

$$Al_2Cl_6 + 2PdCl_2 + 20H_2O.$$

Beryllium-palladium chloride.—A. Welkow.—Formed by mixing solutions of beryllium chloride and palladium chloride. Formula, $BeCl_2 + PdCl_2 + 6H_2O$.

Synthesis of **anthraquinone sulphonic acid.**—C. Liebermann.—Consists in heating β-benzoylbenzoic acid with fuming sulphuric acid.

Correction.—C. Liebermann.—The **colors, obtained from phenoles** by means of nitrous and sulphuric acids, when dissolved in alcohol and weakly acidified, dye silks very beautifully.

On **suberone.**—C. Schorlemmer and R. Dale.—Suberone, obtained by heating suberic acid, has the formula $C_7H_{12}O$. Oxidized it yields an acid, α-pimelic acid, $C_7H_{12}O_4$, which bears the same relation to suberone that camphoric acid bears to camphor.

On the action of **nitrous acid on dimethylanilin.**—Adolf Baeyer and H. Caro.—The product of the action is nitrosodimethylanilin $C_6H_4N(CH_3)_2NO$. When this substance is treated with alkalies nitrosophenole

$$C_6H_4(NO)OH$$

is the result, according to the equation—

$$C_6H_4(N[CH_3]_2)\,NO + H_2O = C_6H_4(NO)(OH) + N(CH_3)_2H.$$

Phenylenediamine as by-product in the manufacture of anilin.—A. W. Hofmann. About forty pounds of this substance were obtained from the factory of Weiler in Cologne.

Another word on the desulphurization of **phenyl mustard oil.**—A. W. Hofmann.

No. II.

On the identity of **phenyl-carbamidol** and **diphenylurea.**—W. Lossen.—Phenyl-carbamidol, which is a product of decomposition of dibenzhydroxamic acid, was found by careful investigation to be identical with diphenyl-urea.

On **tetraphenylguanidine** and **diphenylcyanamide.**—W. Weith.—Tetraphenylguanidine,

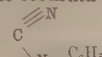
$$CN_3(C_6H_5)_4H,$$

and a polymer of diphenylcyanamide, $CNN(C_6H_5)_2$, are formed by the action of chlorcyan on fused diphenylamine. The constitution of tetraphenylguanidine is represented by the formula

$$\begin{matrix} & & N & C_6H_5 \\ & & & C_6H_5 \\ & C & = & NH \\ & & N & C_6H_5 \\ & & & C_6H_5. \end{matrix}$$

When treated with KOH it yields diphenylamine, ammonia and carbonic acid. The same decomposition is effected by chlorhydric acid. When in passing chlorcyan into diphenylamine the latter is heated to 250°, the product of the reaction is a polymeric variety of diphe-

nylcyanamide. Treated with concentrated HCl, the latter substance yields diphenylamine, ammonia, and CO_2, which shows that its formula is



or, rather, a multiple of this formula.

On the structural formula of **allyl compounds** and **acrylic acid.**—Ed. Linnemann.—The results of this investigation are as follows:—

Acrylic acid, even at the ordinary temperature of the air, takes up nascent hydrogen in acid solution, and is thus converted into propionic acid.

Allyl alcohol, when treated with sulphuric acid and zinc at an elevated temperature, takes up hydrogen and is converted into propyl alcohol.

Allyl alcohol does not take up nascent hydrogen from an alkaline solution.

On a new **dinitrobenzol.**—A. Reime and Th. Zincke.—The new variety is formed together with the known variety in the preparation of the latter from benzol. When treated with ammonic sulphide it yields the nitranilin, which melts at 146°; treated with tin and chlorhydric acid it yields a phenylene diamine, which melts at 140°. This new dinitrobenzol is thus seen to belong to the same series as the ordinary bibrombenzol, or the para-series.

On the conduct of **alcohol yeast** in media free from oxygen.—Moritz Traube.—Author has reached the following results:—

1. Yeast germs do not develop without oxygen, even in a medium most favorable to their development.

2. On the other hand, developed yeast can grow in proper media, even without the presence of oxygen.

3. Pasteur's statement, that when air is excluded the yeast grows by the aid of the oxygen of the sugar, is incorrect, for the growth ceases long before the sugar is entirely decomposed. The growth depends upon the presence of albuminoid substances.

4. In a pure solution of sugar, yeast causes alcoholic fermentation in the absence of every trace of oxygen, and without increasing in quantity. The statement of Pasteur that the fermentation of sugar is connected with the organization of the yeast is incorrect.

5. While grapes produce alcohol from their sugar even when the air is excluded, the expressed juice has not this property.

6. It does not necessarily follow, that alcoholic fermentation is a vital process dependent upon the growth of the cells.

On the constitution of **chrysin** and **tectochrysin.**—J. Piccard.—Chrysin when treated with KOH yields acetophenone, benzoic acid, and phloroglucine. It hence appears to have the constitution—

$$C_6H_3\begin{cases}OCOC_6H_5\\OCOCH_3\\OH\end{cases} - H_2O.$$

It was not established from which portion of the molecule the water is abstracted. Tectochrysin appears to be the next higher homologue of chrysin and to have the formula—

$$C_6H_3\begin{cases}OCOC_6H_5\\OCOCH_3\\CH_3.\end{cases}$$

Communications from the University Laboratory at Würzburg.—J. Wislicenus.

The following compounds have been prepared and studied: **Ethyl diacetsuccinate and acetsuccinate,** ethyl acetmalonate and allylacetacetate.

Further communications on compounds of **iodine and thallium.**—Th. Küosel.—There is a black compound of the formula Tl_2I_3, and three modifications, red, green, and yellow, of TlI.

On the action of **ethyloxalic chloride on sulphourea.**—B. Peitzsch.—A product is obtained of the formula $C_4O_2SN_2H_8$.

Investigations on the **volume constitution of solid bodies.**—H. Schröder.—By an examination of the molecular volumes of natural sulphides, it is found that the volumes of the components of a compound bear a simple relation to each other.

On the new derivative of **prussic acid** containing sulphur.—O. Wallack.—The substance was obtained by allowing H_2S to act upon a concentrated solution of CNK. Then the following reaction takes place:—

$$4CNK + 5H_2S = 2K_2S + SH_2NH_3 + C_4H_5N_3S_2.$$

The name chrysean was given to the new substance.

Resorcin from dinitrobenzol.—C. Wurster and E. Nölting.—Ordinary dinitrobenzol, which, as is known, may be converted into metabrombenzoic acid and isophtalic acid, may, on the other hand, be converted into resorcin. It is first treated with bromine and bromnitrobenzol (fusing pt. 56°) obtained. This is then converted into the corresponding amido-compound, which in turn, through the diazo-compound, yields bromphenol. On now fusing the bromphenol thus obtained with KOH, resorcine in a pure state is the sole product.

Test for **narceine.**—August Vogel.—Chlorine-water is poured upon narceine in a watch-glass, and a few drops of ammonia then added. A deep blood-red color is produced, which does not disappear in an excess of ammonia nor by heating.

On the three **isomeric compounds,** C_2H_4BrI.—H. Lagermarch.—Author upholds his former statement that by the action of bromine and iodine upon ethylene bromide and ethylene, a new variety of the compound C_2H_4BrI is produced.

Investigations on substitution in nitro-bodies of the **fatty series.**—J. Tschermak.—It was found that when nitroethan is added gradually to bromine, so that bromine is always in excess, monobromnitroethan is formed almost alone. An investigation on the bromine substitution products of nitromethans showed that the conclusions already drawn with reference to this kind of substitution are correct. Monobromnitroethan is a strong acid, dibromnitroethan a stronger acid, and tribromnitroethan (brompicrine) is a neutral body, as was foretold.

Communications from the Laboratory of the London Institution.—Henry E. Armstrong.

On the conduct of **nitrophenol** (fusing point 45°), **towards bromine and chlorine.**—By the action of chlorine and bromine on nitrophenol, two isomeric brom- or chlor-dinitrophenols are formed simultaneously.

On the conduct of **nitrophenol** (fusing point 45°), **towards sulphuric acid.**—In this case also two products are formed.

On the position of the sulpho-group in **phenolparasulphuric acid.**

On the decomposition of **dichlornitrophenol** (fusing point 125°) by heat.—All the nitrogen is given off, and among the products is dichlorquinone.

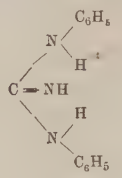
On a fifth **oxytoluic acid.**—F. Fittica.—The acid was obtained from nitrotoluic acid by first converting the nitro-group into NH_2, and then treating with nitrous acid.

Action of **chloroform on sodium-acetic-ether.**—A. Oppenheim and S. Pfaff.—The product is oxyuvitic acid—

$$C_6H_2 \begin{cases} CH_3 \\ OH \\ CO_2H \\ CO_2H. \end{cases}$$

The phenomena of neutralization and the basicity of **arsenous acid** in aqueous solution.—Julius Thomsen.—These investigations show that the molecule As_2O_3 forms a bibasic acid in aqueous solution, and that a hydrate corresponding to phosphorous acid, viz., AsO_3H_3, in case it exists, must be considered as a monobasic acid.

On **diphenylguanidines.**—W. Weith and B. Schröder.—It is found that the varieties of diphenylguanidine designated by α and β are in reality identical. When treated with chlorhydric acid, diphenylguanidine yields CO_2, anilin, and ammonia. Treated with carbon bisulphide, sulphocarbanilide and sulphocyanhydric acid are formed. These reactions lead to the formula—



for diphenylguanidine. This is the only variety of diphenylguanidine known at present. I. R.

Journal für Praktische Chemie.

Nos. 15 and 16, 1874.

On **cyanocarbonic acids,** their ethers and their derivatives.—A. Weddige.—The preparation of the following bodies, their principal properties, and reactions are described in this article, oxamethan :—

Cyanocarbonate of ethyl, $CN.COOC_2H_5$,
Cyanocarbonate of methyl, $CN.COOCH_3$,
Cyanocarbonate of butyl, $CN.COOC_4H_9$,
Paracyanocarbonic acid, $CN.COOH$,

together with its methyl and butyl ethers, its amide, methylamide, and phenylamide. The results of the investigation are thus summed up. The ethers of oxamic acid are converted into the corresponding ethers of cyanocarbonic acid by the action of phosphoric anhydride. These ethers are clear fluids, capable of distillation without decomposition, and may be transformed into derivatives of carbonic acid by the action of water, ammonia, or compound ammonias. Strong acids convert them into oxalic acid. They unite with hydrosulphuric acid, forming sulphur compounds derived from oxamic acid. Bromine and hydrochloric acid convert them into polymeric bodies, the paracyanocarbonic ethers.

On the **phenylic ethers of sulpho-phosphoric acid.**—Dr. Felix Schwarze.—By the action of sulphochloride of phosphorus on phenol, the author obtained phenylismonosulphophosphate, thus :—

$$3C_6H_5OH + PSCl_3 = PS(OC_6H_5)_3 + 3HCl.$$

In like manner the corresponding ethers of di-, tri-, and tetra-sulphophosphoric acids were prepared.

On the action of **benzoylchloride on sulphocyanide of ammonia** in alcoholic solution.—Linné Lössner.—The author in an extended monograph comes to the conclusion that the above-named reaction does not yield benzoylsulphocyanide as maintained by previous writers. In this communication we have abundant examples of the unavoidably (?) cumbrous words now invading the language of chemistry, *e. g.* "Benzoylaethyloxysulphocarbaminsaures Kali."

On the estimation of **urea by means of sodic hypobromite.**—G. Schleich.—An experimental examination of the accuracy of Hüfner's method previously described in this journal.

A quick method of preparing **glycocholic acid.**—G. Hüfner.—When fresh oxgall is treated with a strong mineral acid, a resinous mass precipitates consisting mainly of glycocholic acid. By placing a layer of ether over the gall in a narrow cylinder before the addition of the acid, the milky precipitate becomes crystalline with great rapidity.

On decanting the ether and washing the remaining mass with cold water a crystalline body is obtained easily soluble in boiling water, which after one crystallization from hot water yields a quite pure product.

On the preparation of **glycol.**—A. Zeller.—By following Demole's new method the writer obtained very little glycol, and he writes for further particulars.

On a new method for preparing **glycol.**—A. Zeller and G. Hüfner.—By heating a mixture of bromide of ethylene with potassic carbonate in aqueous solution, pure glycol was readily and abundantly obtained.

H. C. B.

Revue Hebdomadaire de Chimie.

No. 12.

Note on the distribution and **determination of thallium.**—Dissolve the mineral containing it in aqua regia. Dilute the strongly acid solution, and remove the metals which will precipitate with hydrosulphuric acid, filter and boil out the excess of hydrosulphuric acid, treat with a slight excess of sodic carbonate, and filter hot. In the filtrate, ammonic sulphide will precipitate the thallium completely as sulphide.

Means of recognizing the **quality of leather.**—M. Bitner.—Leather not completely saturated with tannin will swell up under treatment with acids. If, however, the tannin has penetrated it thoroughly, no such effect is produced. Acetic acid is the acid recommended for this test.

No. 15.

Apparatus for **determining tannin** in various astringent substances employed in tanning.—A. Kneil.—Description of an apparatus, the operation of which depends on the absorption of oxygen by alkaline solutions of tannin. The amount of oxygen absorbed serves as a basis for the calculation, it being estimated that 0·1 grm. tannin absorbs 20 c. c. of oxygen.

No. 19.

Process of comparative estimation of the **value of substances for tanning.**—M. Schmidt.—A review of the various processes proposed is given. The author proposes yet another process which consists in comparing the results obtained with an alcoholic solution of plumbic acetate on pure tannin, and on the substance to be tested. The solution consists of a solution of 50 grammes plumbic acetate in 400 grammes alcohol of 92° with water added to make the solution up to 1 litre. The end reaction is shown by the use of potassic iodide solution which gives the well-known precipitate with excess of plumbic salt.

No. 22.

Soft soaps and their falsifications.—Dr. Vohl.—Resin or soda when above a certain amount are classed

as adulterations, inasmuch as they impair the quality of the article. Soluble glass, starch of wheat, potatoes, or rye, and infusioral earth are also adulterants. Some examinations of goods cleansed with adulterated soaps are given in detail in order to show what effect such articles produce.

No 23.

Determination of manganese in soils and vegetable products.—M. Leclere.—This consists in oxidizing the manganese present, by treatment with nitric acid and red oxide of lead, to permanganate, and titering with mercurous nitrate. The amount of chlorine present must be determined in order to avoid error from this source. E. W.

Annales de Chimie et de Physique.

September.

Researches on the **spectrum of chlorophyll.**—J. Chautard.—Divided as follows:—

I. Introduction.

II. General observations on the disposition of the experiments.

III. Effect of the concentration of the solution or of the degree of thickness of the layer observed. Specific band. Extra bands.

IV. Effect of the source of light.

V. Effect of the solvent on the spectrum of chlorophyll.

VI. Effect of the portion, the age, and the nature of the vegetable on the spectrum of chlorophyll.

VII. Spontaneous alterations of solutions of chlorophyll, and the modifications which result in the spectrum.

VIII. Modifications produced by light in the spectrum of chlorophyll.

IX. Alteration of the spectrum of chlorophyll under the influence of heat.

X. Modification of the spectrum of chlorophyll under the influence of acids, accidental temporary bands, accidental permanent bands.

XI. Modifications of the chlorophyll bands under the influence of alkalies.

XII. Extra bands produced in solutions of chlorophyll under the influence of sulphurized agents.

XIII. Examination for chlorophyll in various colored substances.

XIV. Conclusions: The spectrum of chlorophyll is characterized by a certain number of bands, among which *one* in the red is found, the special properties of which suffice to distinguish the substance. The qualities of this band are, sensibility, certainty, and generality.

a. Sensibility by the sharp outline, a fixed position, and a remarkable permanence even in a solution diluted to less than $\frac{1}{10000}$.

b. Certainty by the decomposition which it undergoes under the influence of alkalies, a character which belongs neither to blood-bands, those of bile—nor, indeed, to those of any organic liquid.

c. Generality—that is to say, that this band always appears throughout where pure or altered chlorophyll exists.

II. Chlorophyll manifests itself in vegetation in different states, which can be perfectly recognized by the spectroscope. In young leaves, in leaves older or rapidly dried in the dark, and in dead leaves detached from the plant, which have been exposed to the action of air and light.

a. In young leaves in course of expansion the instability of the elements is very great, and is recognized by the appearance of *accidental temporary* bands by the action of hydrochloric acid.

b. In the second case, the same acid causes the formation in the alcoholic solution of quite a different system of bands, which I call *accidental permanent* bands.

c. Finally, in alcoholic solutions of leaves dried in the light, or in those of fresh chlorophyll which have, by lapse of time, undergone alterations, the *accidental* permanent bands appear immediately, without the use of hydrochloric acid.

III. As the final result of the spectrum analysis of chlorophyll, we affirm that this substance, so readily altered when regarded from a physiological point of view, is, on the contrary, much less alterable than is generally supposed. It resists the action of iodine, of acids, of alkalies, of digestive operations, and preserves, under the influence of these agents, if not its composition and its primitive properties, at least characteristics which permit of its being found in the most complex and varied mixtures, and after a considerable lapse of time.

If the alcoholic tincture is destroyed with some rapidity in air, and especially in sunlight, the oily solutions offer a very remarkable resistance to these same agents, the consequences of which we have noted in certain questions of natural philosophy.

A set of colored plates, illustrating the paper, accompanies it.

On the **alcoholic fermentation.**—M. Dumas.—(Not suited for abstraction.)

Researches on **wine.**—E. Duclaux.—Third memoir on the coloring matter of wine, natural and artificial.

Bitter lakes of the Isthmus of Suez.—F. de Lesseps. E. W.

Les Comptes Rendus de l'Academie des Sciences.

Vol. lxxix. No. 5.

8th note on **guano.**—E. Chevreul.—(Not suitable for abstraction.)

On the **passive state of iron.**—A. Lenard.—Showing the effect of the electric current and of other metals on the passivity of iron. Oxidizing agents are found to have no action on passive iron. Reducing agents destroy its passivity.

Constitution of ordinary **propylene bromide.**—Giving the results of the study of ordinary propylene bromide, with a view of establishing clearly the difference between this (CH_3—CH=CHBr) and its isomer (CH_3—CBr=CH_2) derived from methyl-bromacetol. The ordinary propylene bromide seems to be a compound made up of two bromides with different boiling points, and with different properties. From this it seems probable that the higher members of the series $C_n H_{2n-1} Br$ derived by the subtraction of HBr from the bromides $C_n H_{2n} Br_2$ which contain their two atoms of bromine in distinct carbon groups, are not simple substances, but mixtures of two isomers.

Action of **nitric acid on paraffine**; various products resulting from the reaction. These are divided into two classes:—

1. Products soluble in the mother-liquor and wash-water.

2. The same insoluble.

The *first* class includes many of the fat acids, caproic, œnanthylic, caprylic, etc.; also succinic, adipic, and pimelic acids.

The *second*, to which particular attention is directed, is a new acid called *paraffinic acid*. Its production, properties, and salts are described at some length, and,

from its constitution, the definite composition $C_{48}H_{50}$ is assigned to paraffine, instead of regarding it, as hitherto, a mixture of different hydro-carbons.

No. 6.

The **artificial production of animal charcoal** for decolorizing purposes, consisting in soaking woody matter in phosphate of calcium dissolved in hydrochloric acid, washing out the chloride of calcium with water, and then calcining.

On the constitution of **clays.** (Note 2.)—The different silicates of alumina forming clays do not admit of accurate separation. They may, however, be roughly separated by suspension in feebly alkaline distilled water, levigation, etc. This method of analysis is also discussed as applied to kaolins.

Determination of **tannin.**—Recommending a quantity of a solution of tannin to be forced through hide, then equal quantities of this, the filtrate, and the original solution to be evaporated to dryness, and the former weight subtracted from the latter gives corresponding amount of tannin, since the hide absorbs the tannin, but lets the gums, sugars, organic salts, etc., pass through it.

On the arrangement of an apparatus for receiving **iodine** liberated during the **manufacture of superphosphate of lime.**—Many of the phosphates of lime used for the manufacture of superphosphates contain a little iodine, probably in the form of the calcic salt. This is liberated during the process and collected in an iron cylinder in which is coke with a stream of water trickling over it. The iodine by attacking the apparatus is reduced to the state of proto-iodide of iron. Some chloride and fluoride of iron are also formed, but no bromide. The iodine may be separated from the proto-iodide of iron by Serullas' method, precipitating as cuprous iodide, and heating with an excess of sulphuric acid. This process is incomplete, since by no means all the iodine is expelled in the gaseous form, and in view of the high price of iodine it is highly desirable that some method should be devised of expelling all the iodine from the phosphate of lime.

On the **etherification of glycol,** showing—

1st. The reciprocal action of oxalic acid and glycol is similar to that of glycerine.

2d. It differs in that the formates are in part removed, and the diformate found in the distillation of the formic acid products.

3d. The formates may be obtained as well by the substitution of potassic formate for the acetate in the preparation of glycol, and a considerable quantity of free glycol is also formed.

4th. Glycols generally and their ethers may be prepared by the use of a salt and an alcohol with bibromide of ethylene, with the simultaneous production of an ether of the monatomic alcohol.

On **Tetraterebenthene,** a polymeric solid of the extract of terebenthine.—Obtained by the action of antimonous chloride on terebenthine. The properties of this body ($C_{40}H_{64}$), are here given at some length, together with the analysis of it, and action of heat upon it.

On the **albumens of white of egg**—in reply to Mr. Gautier.—A. Bechamp.—Showing that the white of egg contains three varieties of soluble albuminoid matter, and giving their difference in rotatory power, etc.

Analysis of **meat sold in Paris market,** 1873.—C. Méne.—First the bone is removed, then the meat treated with bisulphide of carbon to remove the grease, dried at 100°, treated with cold water acidified with HCl, and then with ammonia to remove the albumen and fibrin, incinerated to obtain inorganic salts, soaked in boiling water an hour to extract the gelatine, and finally the cellular tissue, nerves, etc., determined. Another series of analyses with soda lime and oxide of copper gives the elementary composition. An extended table of the results is appended, and they show that the composition is not the same in different parts of the same animal.

No. 7.

Report on a memoir of P. A. Favre on the equivalence and transformation of **chemical force.**—Berthelot, Dumas, Sainte Claire Deville.—This memoir comprises the results of numerous investigations on the correlation of force, with special reference to chemical energy. It is to be published, with additions, by the Academy.

On apparatus for **fractional distillation.**—The apparatus most commonly used is that devised by M. Wurtz, but its use is very tedious in the separation of liquids mixed in very unequal proportions, and for this purpose a room with reflux, in a bath at a fixed temperature, is recommended.

On **fluoxyborates.**—Fluoxyboric acid is not known, but neutral fluoxyborate of sodium ($NaBoO_2$, $3NaFl + 4H_2O$), was described by Berzelius, and prepared from one molecule neutral borate of sodium, and three of fluoride of sodium. Results of analysis of it given. The existence of other fluoxyborates seems to be doubtful.

Determination of **sulphides in mineral springs.**—F. Garrigon.—Giving the results of analysis of mineral waters from Bayen, de Luchon, leading to the following conclusions:—

1st. Sulphurometry as commonly practised is an excellent method of determing various sulphides, sulphuretted hydrogen, etc.

2d. To obtain the amount of free or combined sulph. hydrogen contained in a mineral water, add carbonate of lead, and estimate the carbonic acid set free.

3d. The water here analyzed contains alkaline sulphydrate of sulphur, and not monosulphide of sodium.

This last fact is considered at some length.

J. M. M.

Journal de Pharmacie et de Chimie.

August, 1874.

On the extraction of **crystallized digitaline.**—The digitalis of the Vosges gave the best results. The leaves are first treated with one-fourth their weight of neutral plumbic acetate dissolved in water, in a displacement apparatus, and the exhaustion is finally completed by 50% alcohol. A saturated solution of sodic bicarbonate is then added, and the mixture distilled. The remaining liquor is evaporated down—cooled and then diluted, and allowed to stand when the liquor is decanted. Repeatedly dissolving in alcohol, treatment with neutral plumbic acetate and charcoal, distilling off the alcohol, and finally treatment with ether, is necessary to purify the product. The details are lengthy and extremely minute.

Pyrogallol in the presence of iron salts.—E. Jacquemine (concluded).—By means of the pyrogalloferric chloride an alkaloid may be readily distinguished from a glucoside. An alkaloid immediately turns blue with this reagent, while a glucoside produces no change. The solution may be used as a more delicate test for alkalinity than litmus paper. The reactions described in this and the preceding papers may also be made use of in dyeing cotton.

On the **red coloring matter of blood.**—M. Bechamp.—Mode of separating it.

Chemical researches on the **brain.**—M. Gobley.—The cerebral pulp contains—

Water, about	. .	80 per cent.
Albumen, "	. .	1 "
Cephaline, about	. .	7 "
Cholesterine, "	. .	1 "

On creatine.—M. Engel.—Argentic nitrate, with a little potassa, is mentioned as a reagent for creatine. The reaction is described as follows: To two c. c. of a cold saturated solution of creatine five to six drops of argentic nitrate solution ($\frac{1}{4}$) are added, and then to the mixture, by means of a glass rod, potassic hydrate is added, drop by drop, until a white precipitate forms, which dissolves in an excess of the potassa. After a short time the solution becomes so gelatinous that the vessel containing it may be inverted without spilling. With mercuric chloride and potassa after a short time a white crystalline precipitate forms, which is insoluble in and does not blacken with an excess of potassa.

On a **new reagent for iodates.**—E. Pollacci.

Pharmacographic and chemical study of a **new substitute for Angustura bark.**—Oberlin and Schlagdenhauffen.—This bark, which has been used to adulterate and replace the true Angustura, is the bark of the Eseubeckia febrifuga or Evodia febrifuga, large quantities of which grow in some provinces of Brazil.

On the **cinchona hass karliana of Java.**—De Vry.—The author believes that this is not a true species, but a hybrid from C. calisaya and C. pahudiana.

Subcutaneous injections of magnesic sulphate.—Peculiar toxical symptoms, but no purgative effects, were found to be produced by subcutaneous injections of magnesic sulphate.

On the **carica papaya.**—The juice of the fruit of this plant appears to contain a substance similar to animal fibrine; it also has the property of dissolving meat and other albuminous substances.

Toxicological researches on **phosphorus.**—J. Lefort.—The liver of a subject poisoned by phosphorus contained less phosphorus than that of a subject deceased from atrophy of the liver. The kidneys and lungs of both subjects contained about the same amounts; the one poisoned by phosphorus containing a little the larger quantity. The proportions of phosphoric acid in various articles of food are given. After a discussion of the question, it is concluded that neither the presence nor the quantity of phosphoric acid, nor of crystals of ammonio-magnesic phosphate in a corpse, or in decomposing articles of food, can be considered as proofs of poisoning by phosphorus.

Falsification of opium.—M. Romans.—A cake of clay weighing 2½ ounces was found in a mass of opium weighing 28 ounces.

On the presence of large amounts of **carbonic acid in the urine in fevers.**—E. and C. A. Ewald.—Urine from fever patients contains 16 to 17 volumes per cent. of carbonic acid, while normal urine contains about 13.

September.

Chemical researches on the **brain.**—M. Gobley.—(Continued.)—The proportion of cerebrine in the brain is about 3 per cent., of lecithine about 5·5 per cent. Oleine and margarine could not be detected. The amount of soluble salts was found to be 0·5 per cent., and of extractive substances (among which were detected inosite, creatine, and xanthine) 1·5 per cent. The salts consist of potassic and sodic chlorides, potassic phosphate, sodic carbonate, and calcic and magnesic phosphate. The chemical properties of the organic constituents are briefly sketched. The brain immediately after death has no effect on the color of litmus paper, but soon—before there are other evidences of decomposition—the reaction is acid.

Action of **potassic permanganate on sulphides.**—M. Schlagdenhauffen.—With arsenic and antimony sulphides some potassic sulphate forms after a time. With stannic sulphides stannic oxide and sulphur form. Plumbic sulphide has but little action; mercuric sulphide also acts very slowly. Copper, bismuth, iron, nickel, cobalt, manganese, and zinc sulphides reduce the permanganate, the sulphur being completely converted into sulphuric acid. Alkaline sulphides oxidize rapidly, but the action is different, when the permanganate is added to the sulphide, from the action when the mode of mingling the two reagents is reversed.

Means of **detecting mineral acids in vinegar.**—M. Strohl.—Take 50 c. c. of the vinegar, add 0·5 c. c. of a $\frac{1}{5}$ normal solution of ammonic oxalate, and the same amount of a $\frac{1}{5}$ normal solution of calcic chloride. If, after agitation, the turbidity does not completely disappear, the vinegar contains per litre—

Less than 2·85 grms. HCl
" 4·40 " HNO_3
or " 1·70 " H_2SO_4.

If the turbidity disappears completely, the vinegar contains at least the amount represented above.

On the **density of cholesterine.**—C. Mehu.—Inasmuch as cholesterine, when thrown into water, has been observed to float, the conclusion has been made that it is lighter than water. The author, however, finds that it floats in consequence of minute bubbles of air adhering to its surface and between the laminæ, and that its density is between 1·04 and 1·05.

On **iron reduced by hydrogen.**—P. Carles.—From experiments on various samples of iron reduced by hydrogen, it is concluded that iron thus produced is by no means pure, but contains, besides silica and sulphur, much oxide.

Note on the **quinine bromhydrate,** and the preparation of a neutral bromhydrate.—M. Boille.—The neutral bromhydrate is prepared by double decomposition of quinine sulphate with barium bromide in alcoholic solution. The neutral bromhydrate has the formula—

$$C_{40}H_{24}N_2O_4.HBr2HO.$$

The acid bromhydrate is—

$$C_{40}H_{24}N_2O_4.2(HBr)6HO.$$

On a mode of **estimating bismuth.**—MM. Bussion and Ferray.—Precipitation by iodic acid is recommended, with addition of sulphuric acid and potassic iodide, afterwards, to set the iodine free, which is then titred by sodic hyposulphite.

On the preparation of **cantharidine.**—M. Galippe.—Acetic ether is preferred by the author to chloroform for the extraction of cantharidine.

Preparation of **quinine wine,** and determination of the alkaloids therein contained.—F. Vigier.

Action of **chloral on the blood.**—V. Feltz and E. Ritter.—The idea that chloroform is formed in the body from the administration of chloral is here disputed.

On the **antiseptic properties of heavy oil of tar.**—L. Dusart.

Note on **tests for iodine.**—M. Pollacci.—Hyponitric acid and calcic hypochlorite may be used for the detection of iodine in urine, as follows: Place in a test-tube 3 or 4 c. c. of urine, add a few drops of a solution of starch, agitate and pass hyponitric acid into the mixture. If one part of potassic iodide in 60,000 is present, the

blue color makes its appearance; calcic hypochlorite solution added to urine containing starch also gives a very delicate reaction. E. W.

Le Technologiste.

No. 401.

On the preparation of **potassiocalcic chromate** free from chlorine.—F. Stolba.—In titering with argentic nitrate for chlorine and chlorides, by Mohr's method, it is of the greatest importance that the chromate used as an indicator should be free from chlorine. To insure this the author proposes taking pure crystallized potassic dichromate and adding to it pure calcic hydrate (which may be readily obtained free from chlorine) until the liquid assumes a clear yellow color, and then evaporating or passing a current of carbon dioxide through it to remove excess of lime.

No. 402.

On a sophistication of **ultramarine.**—C. Furstewan.—By means of a method here described, finely ground gypsum is covered with a pellicle of ultramarine in such a manner that it assumes the appearance of a genuine unadulterated article.

No. 403.

Determination of **caustic soda in presence of sodic carbonate** in commercial soda salts.—E. Sièquart.—Turmeric paper in presence of caustic soda assumes a medium red color, with sodic carbonate a crimson red. The titration is conducted in the ordinary way, except that the point at which the solution begins to color turmeric paper crimson red is noted as the point of saturation of the caustic soda.

To **cover cotton with silk.**—A. Muller.—The silk may be dissolved in hydrochloric acid, or ammoniacal solution of copper or nickel. The solution is filtered through sand, diluted until it begins to cloud, and the cotton, previously mordanted, is then immersed in it for two or three minutes, then removed and washed. The process is patented by the author.

Impermeable silk paper.—R. Jacobson floats silk paper for a short time on a water solution of gum lac and borax. By this treatment the paper becomes translucid and impermeable to water and fatty substances. E. W.

Zeitschrift für Zucker Industrie.

Vol. III. Nos. 6 and 7.

On the action of **phosphoric acid added to beet-root juice.**—A. Schær.—Three experiments are detailed, showing that the use of phosphoric acid gives a product containing a larger amount of available sugar then when that acid is not used.

Nos. 8 and 9.

Researches on the nature of the **gelatinous precipitate** (so called "frog-spawn"), observed in obtaining sugar liquors from beets.—Dr. C. Scheibler.—The phenomenon was especially observed to appear (1) when some of the beets used were immature (unripe); (2) at the beginning of a campaign, a regular decrease being observed as the campaign progressed. This appears to be largely due to the protoplasms of the beet cells containing an anhydride of dextrose (starch sugar), called by the author *dextran*, the empirical formula of which is $C_6H_{10}O_5$, rotary power + 302. Boiled or heated to 120° or 125° in sealed tubes with sulphuric acid, it is converted into grape-sugar. Nitric acid converts it into oxalic acid. Fuming nitric acid converts it into an amorphous nitro-compound soluble in alcohol. This substance may readily be detected in the molasses by diluting 200 to 300 grms. with 100 c. c. of water, acidifying strongly with hydrochloric acid, adding alcohol as long as turbidity is caused, when the dextran settles out as a pasty fibrous mass. By decanting the solution, dissolving in water, and reprecipitation with alcohol, the substance may be still further purified, and to insure purity of product this operation may be repeated two or three times.

On the **absorption of calcic sulphate by bone-black.**—E. F. Anthon.—On passing a concentrated solution of calcic sulphate slowly through bone-black, it was found that the calcic sulphate, instead of being absorbed, was in greater part decomposed, the lime being left in the black, while the filtrate consisted almost entirely of ammonic sulphate.

Molasses residues and their value as fertilizers.—A. Gawalowski.—In working 300,000 cwt. of beets and 7500 cwt. molasses, the amount of substances as salts of value as fertilizers would be as follows:—

Potash	495 cwt.
Lime	37½ "
Phosphoric acid	4½ "
Sulphuric acid	18¾ "

The value of these would be over 5000 florins. The residues contain only 8 to 9 per cent. of these salts, so that the water and useless material should in some way be more or less removed in order that the cost of transportation may be diminished. The various modes proposed are discussed.

No. 10.

On the technical analytic management of the **manipulation of bone-black.**—F. Jicinsky.—On the decolorizing properties of the black. These properties, as is shown by experiment confirmatory of those of other observers, is quite independent of the amount of carbon in the black. In revivification strong ignition is recommended. E. W.

La Sucrerie Indigene.

Vol. ix. No. 5.

Application of **osmose.**—MM. Leplay and Cuismer.—Letter from a Belgian sugar refining company confirming all that M. Dubrunfaut (the inventor) claims for his apparatus and mode of working the first and second run of beet-sugar liquors.

Practical course in **sugar making.**—M. Vivien.

Bone-black revivification.—Klusemann's washer.—Drying and calcining the black. The temperature of calcination should be about a dull red heat 450° to 600°. The decolorizing power compared with the temperature of calcination is given as follows:—

Decolorizing power.	Temperature of calcination.
80	125°
90	204°
100	315°
110	425°

after calcination the black must be screened and scraped (decorticated). Schreiber's machine for this purpose is described. The loss in revivification is 1·2 to 2 per cent., in scraping and screening 2 to 3 per cent.

No. 6.

Practical course in **sugar-making.**—M. Vivien.—Other mixtures for screening and scraping the black are described. A table of expense on the black necessary for an establishment working 20 million kilos of beets in 100 days is given. The question of disposition of the

waste waters of a sugar factory is discussed, and it is strongly recommended that they be used for purposes of irrigation and fertilization. E. W.

Journal für Gasbeleuchtung.

No. 9, 1874.

On the **estimation of acetylen** in mixtures of gases.—Dr. Blochmann.—Berthelot and Landolt have given as the mode of determining acetylen in illuminating gas, to pass the gas through an ammoniacal copper solution, decompose the precipitate, and measure the volume of acetylen evolved. The author proposes washing the cupric acetylide thoroughly with dilute ammonia, filtering, moistening with a little nitric acid, igniting, and weighing the cupric oxide remaining. A careful analysis of the cupric acetylide showed it to have the formula $C_2H_2Cu_2O$, or it contains 75·15 per cent. copper, assuming that

v = volume of dry illuminating gas passed through the copper solution,
t = its temperature,
p = the height of the barometer,
g = the weight of the cupric oxide obtained,
the percentage, by volume, of acetylen in the gas, will be

$$x = 100\frac{g(1 + 0{\cdot}00300\,t)}{v.\,p.}0{\cdot}107055$$

No. 15.

On the possibility of safely fixing upon **a standard of light** for photometric observations.—Dr. N. A. Nippoldt.—The intensity of the light afforded by a portion of the flames, and the height of the gas flame, are the data taken into account for what is believed to be a more accurate mode of determining the illuminating power of a gas.

No. 18.

Further communications on the **regeneration of the purifying material** by the steam blast.—Gralen.—Description of the apparatus, accompanied by a plate.

Comparison of the **cost of the application of spirits, petroleum, and illuminating gas** for heating operations in the laboratory.—Prof. Wagner.—The most costly material is spirits, which costs three times as much as petroleum or gas. Petroleum and gas cost nearly the same, the former being a little cheaper. The tests were made by noting the time and heating material consumed in raising the temperature of a given amount of water from 12° to 95°, the same vessel or vessels of the same shape and size being used in each case. E. W.

Reimann's Färberzeitung.

No. 7, 1874.

On **pulverizing indigo**.—The addition of calcined soda the night before pulverizing indigo is recommended for the purpose of softening the indigo. 3 ounces is sufficient for the ordinary kinds (Guatemala, Rurpah, etc.), half that amount for the better qualities.

Oil mordant.—6 pounds olive oil,
8 pounds spirits,
8 pounds boiling water,
stir thoroughly and mix in ¾ lb. English sulphuric acid previously diluted with water. Stir thoroughly before using.

No. 8.

Economizing indigo.—Goods dyed with indigo on coming from the vat have considerable amounts of indigo adhering to them which is rinsed from them and lost. It is recommended to rinse with lukewarm water containing a little soda, and to allow the rinsing water to stand in a vat to deposit this indigo, which may thus be saved.

Nos. 14, 15.

Detection of **artificially colored red wine.**—Dilute the wine with twenty times its volume of water. On addition of plumbic acetate solution (1:10) the color of genuine wine will then disappear, the solution becomes turbid, and, on heating, small silver-gray flocks with a reddish cast separate out. Artificially colored wine, under these circumstances, gives large curdy flocks of a dark violet color. Solution of cupric sulphate (1:10) with unadulterated wine destroys the color without causing turbidity. With artificial wine the color becomes violet-blue, and a slight turbidity appears. Baryta water (1·10) destroys almost completely the color of unadulterated wine, showing at the same time a trifling turbidity. With colored wines the solution becomes violet-blue to bluish-green, and at the same time the wine is rendered turbid. Soaking filter paper in the reagents above mentioned, and placing a drop of the wine on the paper is mentioned as a mode of applying this test.

No. 19.

Detection of saffranin in substances.—A bit of dye-stuff over which a few drops of concentrated sulphuric acid have been poured, if saffranin gives a green color, which after a time becomes blue, fuchsine gives a brownish-yellow color. A weak solution of saffranin in alcohol is dichroic, appearing by reflected light as if turbid, and ponceau to scarlet, while it has a delicate rose tint by transmitted light. If the dye is on a piece of goods, enough of the color may be extracted by boiling alcohol, to show this reaction. A five per cent. solution of soap in water will extract some of the fuchsin from goods dyed with it; leaving the shade somewhat lighter; but this effect is not produced on goods dyed with saffranin.

No. 22.

Carbonizing wool.—Mode of destroying the cotton fibres of half wool goods, in order to separate out the wool. The dry method consists in exposing the goods to a tolerably high heat in the vapors of hydrochloric acid. The wet method consists in treating the goods for half an hour in a solution of sulphuric acid of 15° B., to which 2 lbs. oxalic acid and 2 lbs. of salt have been added, drying at 45 to 50°, and then neutralizing the remaining excess of acid by a weak soda solution.

No. 28.

Forming a **fine violet ground**, etc., on indigo vat woolen goods.—By treating the goods a few times successively with soda lye and a sulphuric acid bath, a fine violet color is imparted to the goods.

No. 29.

Anilin ponceau.—This color has never before been in the market in such a form as to be of value. A new article prepared by Schleunberger is mentioned as having been recently introduced.

No. 32.

Utilization of old nets.—The nets used to contain the woollen goods when they are dipped in the indigo vat become after a time saturated with indigo. The writer states that by a simple and expeditious process the whole of the indigo taken up by the net may be made available. He does not, however, state in what his process consists.

Australia fibre.—A new fibre imported from the English market, resembling jute, but much finer.

E. W.

Deutsche Industrie Zeitung.

No. 35, 1874.

On the manufacture of **saffranin.**—Adolf Ott.—The author recommends to pass nitrous acid into heavy aniline oil containing toluidine, and then allowing arsenic acid to act upon this nitro-compound at a low temperature, as in making fuchsin. When the oxidation is complete, the mass is boiled in lime-water, filtered through a cloth filter containing sand, saturated with hydrochloric acid, and concentrated.

On the preparation of **chrome yellow** and orange.—Dr. M. Fandel.—The following proportions are recommended for yellow: 10 parts sugar of lead dissolved in 10 parts hot water, and diluted with 10 parts cold water. To this is added a solution of 2 parts potassic dichromate in 10 parts of hot water and 1 to 2 parts concentrated sulphuric acid 66° B. For an orange color: 10 parts sugar of lead, dissolved in 5 parts of hot water and 13½ parts caustic soda of 11° B. To this is added a solution of 2·3 parts potassic dichromate in 2 parts hot water and 8 parts of soda lye, and boiled.

Salycylic acid.—Kolbe.—Phenol and the solid hydrate of an alkali, or alkaline earth, are placed in an iron or glass retort, and heated some time to 185° C., to expel excess of phenol. Dry and pure carbonic acid is next passed into the retort, forming salicylic or para-oxybenzoic acid. E. J. H.

Annales du Genie Civil.

No. 10, 1874.

Desilverization of lead.—The zinc scums containing silver are first heated in a reverberatory to liquate out the excess of lead, after which the scums are placed in another reverberatory over a thin layer of molten lead and covered with litharge. On heating this up the silver is carried into the lead which is then expelled.

Manufacture of sugar.—M. Pottier treats the sugar with tartaric acid in sufficient proportion to remove the potassa as acid tartrate. The excess of tartaric acid is removed by treatment with lime, and finally with carbonic anhydride.

Tanning with zinc chloride.—MM. de Meriteus & de Kresser.—Soak leather for 24 hours in a solution of zinc chloride (1·10), and then in a solution of soap (1·20). The combination of zinc chloride and gelatine may be used for various other industrial purposes.

New process of transforming **sodic sulphate.**—The sulphate is mixed with silica and charcoal, and heated to red heat in a retort of the size and shape of a gas retort. The products are sulphur, sulphurous acid, and sodic silicate. The sulphurous acid may be used for the manufacture of sulphuric acid, or for that of sulphites and bisulphites. The sodic silicate may be used in glass making, or converted into carbonate by treating with carbonic acid, or into caustic soda by treatment with lime.

Distillation of **beet pulps.**—Marguerite causes the otherwise waste beet pulp to ferment, and distils off the alcohol, as an accessory product.

Purification of wools.—M. Raulin Eleanse.—Raw wool, by subjecting it first to the action of air at 30° to 40°, then to a current of dry and cool hydrochloric acid gas, then air to remove the hydrochloric acid. The wool is then gradually heated up to 130°, and finally the last traces of acid are neutralized by a short exposure to ammoniacal fumes. By this means all vegetable fibres are destroyed and removed. E. W.

Zeitschrift des Vereines Deutscher Ingenieure.

No. 9, 1874.

Utilization of pyrites residues for iron.—Dr. P. W. Hofmann.—The pyrites after roasting in the sulphuric acid factories still contains sulphur, and cannot be used in its crude state for the manufacture of iron. The Meggen pyrites was found to contain zinc blende, which in the course of roasting became converted into zinc sulphate, which would not readily part with its sulphuric acid. By lixiviation after thorough roasting this sulphate mixed with some ferrous sulphate was extracted, and the iron oxide was found then to be free from sulphur, and suitable for use in the blast furnace. By treating the liquors with salt, and concentrating to 30° B., sodic sulphate crystallized out. By concentrating further to 50° B., the excess of salt and zinc and iron sulphates crystallized out, leaving a quite pure solution of zinc chloride, suitable for use in burnettizing wood.

The **so-called German potashes.**—Prinzhorn.—This was found to be an article fraudulently put in the market claiming to be true potashes. Its composition was found to be—

Sodic sulphate	26·68
" carbonate	1·12
" chloride	0·05
Calcic carbonate	17·57
Baric sulphate	23·98
Alumina	0·12
Water	29·43
	100·00

E. W.

RECENT CHEMICAL PATENTS.

August 11th, 1874.

153,887.—Putting up Caustic Alkalies.—G. H. Chinnock, Brooklyn, N. Y.

153,939.—Artificial Ivory, Corals, etc.—J. Frauenberger, New York, N. Y. Caseine and solution of copal in ammonia and alcohol.

153,999.—Processes for Separating Oleomargarine and Stearine from Animal Fat.—W. E. Andrew. New York, N. Y.

154,009.—Apparatus for Generating and Carburetting Hydrogen Gas.—LaFayette Bingham, New York, N. Y.

154,017.—Fertilizing Compounds.—B. J. Carter, Oatlands, Va. Guano, dissolved bone, wood-ashes, soda, and ground plaster.

154,093.—Treating Sewage.—H. Y. D. Scott, Ealing, Eng.

August 18th

154,153.—Treating Anthracine and the Manufacture of Dyes.—C. Runoff, New York, N. Y., and F. Bayer, F. Weskott, and A. Siller, Barmen, Prussia. Anthraquinon obtained by heating anthracene with peroxide of manganese.

154,163.—Composition for making Imitation Marble.—J. H. Wright, Louisville, Ky. Gypsum, hydraulic-cement, sugar of lead, and alum.

154,178.—Removing Tin from Tin Scraps.—W. H. Hanberg, London, Eng.

154,215.—Processes of Preserving Hops.—T. A. Breithaupt, Carlsruhe, Grand Duchy of Baden.

154,251.—Treating Animal Fats.—J. Hobbs, Boston, Mass.

154,309.—Treating Grain for Distillation.—A. Woolner, Louisville, Kentucky.

August 25th

154,317.—Alloys for Anti-friction Metals.—M. H. Campbell, Syracuse, N. Y. Copper, spelter, and aluminium with silicon. Before casting add tin.

154,372.—Treating Animal Fats and Manufacturing Artificial Butter.—W. L. Churchill, Rahway, N. J., and J. L. Englehart, New York, N. Y.

154,435.—Nickel Plating.—Isaac Adams, Jr., Boston, Mass.

154,438.—Processes of Decarbonizing and Annealing Iron and Steel.—J. E. Atwood, Pittsburg, Pa.

September 1st.

154,575.—Compositions for Sizing and Waterproofing Paper.—J. Avil and Wm. Pugh, Philadelphia, Pa.—Water, soda, lime, lard or tallow, glue, bichromate of potash, and linseed oil.

154,632.—Blowpipes.—F. C. Barber and O. J. Price, Oxford, Mich.

154,643.—Processes and Apparatus for the Manufacture of White-lead.—L. Brumlen, Hoboken, N. J.

154,660.—Filters.—J. G. Fulghum, Nashville, Tenn.

154,701.—Composition Fuels.—J. A. Mars and William Irelan, Jr., San Francisco, Cal. Pulverized coke, fire-clay, asphaltum, salt, glycerine, and water.

154,722.—Processes for Bleaching and Clarifying Saccharine Juices.—R. Soule, Brookline, Mass. Chloride of lime and sulphate of alumina.

September 8th.

154,758.—Apparatus for applying Ozone for Purifying Oils, etc.—C. H. Johnson, New Brighton, Pa.

154,767.—Preserving Wood.—J. M. Reid, Alleghany City, Pa.

154,772.—Apparatus for Distilling Hydrocarbon Oils.—S. Van-Sykel, Titusville, Pa.

154,794.—Carbonic-acid-gas Generator.—E. C. H. Hildebrand, Chicago, Ill.

154,898.—Artificial Stone.—A. Pelletier, Washington, D. C. Sand, pulverized stone, coke screenings, iron slag, hydraulic cement, mineral oxide, and correspondiug chloride.

September 15th.

155,041.—Carbonic-acid-gas Generator.—H. Pietsch, Milwaukee, Wis.

155,069.—Machine for making Clay Retorts.—W. D. Cliff, Wortley, near Leeds, Eng.

September 22d.

155,136.—Manufacture of Steel by the Open Hearth Process.—T. S. Blair, Pittsburg, Pa.

155,141.—Paint Compounds.—W. E. Brock, New York, N. Y. Silicate of soda, finely-pulverized stone, carbonic-acid water, and hydrofluoric acid.

155,176.—Manufacture of Artificial Stone.—J. J. Bartlett, New York, N. Y. Mixture of asbestos and cement treated with alkaline silicates and muriatic or sulphuric acid.

155,191.—Processes for Preserving Wood.—Th. Jones, Harewood House, Calstock, Eng. Solution of tungstate of soda free from phosphates or sulphates.

155,341.—Fertilizers.—G. E. E. Sparhawk, Gaysville, Vt. Air-slaked lime, wood-ashes, hen guano, well rotted sod, gypsum or Onondaga plaster, salt, and bone dust.

September 29th.

155,368.—Treating Oxidizable Metals with Chloride of Calcium.—H. P. Dechert, New York, N. Y.

155,441.—Belgian Zinc Furnaces.—T. Hiertz, St. Louis, Mo.

155,508.—Apparatus for Treating Ammonia.—J. H. Elwert, Geneva, and J. J. M. Pack, Basil, Switzerland.

155,537.—Compositions of Matter for Artificial Stone.—J. McLean, Jackson, Mich.—Lime, peroxide of iron, black oxide of manganese, alumina, silica, magnesia, anhydrite.

155,559.—Fuel from Coal-dust.—S. J. Whiting and J. K. Blyler, Philadelphia, Pa.

155,564.—Lead Furnaces.—J. V. Woodhouse, Mine La Motte, Mo.

BOOKS RECEIVED.

The Aborigines of Northern Formosa. By Edward C. Taintor, A.M., F.R.G.S., Commissioner in the Chinese customs service. Pamphlet, 8vo. 54 pp. Shanghai, China, 1874.

Medical Reports for the Half Year ended 30th September, 1875; forwarded by the Surgeons to the Customs at the Treaty Ports in China; being No. 6 of the series, and forming the sixth part of the *Customs Gazette* for July-September, 1873. Published by order of the Inspector-General of Customs. Pamphlet, quarto. 69 pp. Shanghai, China, 1874.

Rapid Transit.—A communication by Richard P. Morgan, Jr., C.E. Pamphlet, 8vo. 29 pp. New York, 1874.

Metallurgical Properties of the Missouri Iron Ores, from Geological Report of the State of Missouri, 1874. By Adolph Schmidt, Ph.D. Pamphlet, 8vo. 16 pp. Jefferson City, Mo., 1874.

Report of the Commissioner of Agriculture for the Year 1873. 8vo. 496 pp. Washington, D. C., 1874.

Report on the Compressive Strength, Specific Gravity, and Ratio of Absorption of Various Kinds of Building Stone from Different Sections of the United States. By Q. A. Gillmore, Lieutenant-Colonel of Corps Engineers, Bvt. Major-General U. S. A. Pamphlet, 8vo. 15 pp. Washington, D. C., 1874.

Report of the Board of Commissioners on the Irrigation of the San Joaquin, Tulare, and Sacramento Valleys of the State of California. By Lieutenant-Colonel B. S. Alexander, Corps of Engineers U. S. A.; Major George H. Mendell, Corps of Engineers U. S. A.; Prof. George Davidson, United States Coast Survey Commissioners. Pamphlet, 8vo. 91 pp. Washington, D. C., 1874.

Report of the Joint Standing Committee on Water, together with the Report of the City Engineer in Reply to Orders of the City Council pertaining to an increased Supply of Water from the Cochituate and Mystic Lakes combined, and an Additional Supply from Charles River. Pamphlet, 8vo. 134 pp. Boston, Mass., 1874.

Chemisch-technisches Repertorium. Von Dr. Emil Jacobsen, 1873. Zweites Halbjar. 8vo. 276 pp. Berlin, 1874.

Deutscher Chemiker-Kalender.—Jahrbuch und Notizbuch. Von Dr. H. v. Gehren. Erster Jahrgaug. 12mo. 84 pp. Dresden, 1875.

Die Chemisch-technischen Mittheilungen des Jahres, 1873–1874. Von Dr. L. Elsner. Pamphlet, 8vo 250 pp. Berlin, 1875.

On the Estimation of the Sanitary Condition of Communities and the Comparative Salubrity of Towns. By Henry Letheby, M.B., M.A., etc. Pamphlet, 8vo. 31 pp London, Eng., 1874.

Notes of Work by Students of Practical Chemistry in the Laboratory of the University of Virginia, No. III. Communicated by Prof. J. W. Mallett. Pamphlet, 8vo. 15 pp. Reprint from the *Chemical News*, London, Eng., 1874.

Clinical Ureametry. By Henry G. Piffard, M.D. Reprinted from the New York Medical Journal, December, 1874. Pamphlet, 8vo. 7 pp. New York, 1874.

Fifth Annual Report of the Secretary of the State of Michigan, relating to the Registry and Return of Births, Marriages, and Deaths for the year 1871. By Daniel Striker, Secretary of State. 8vo. 376 pp. Lansing, Mich., 1874.

A New Method of Determining the Position of Absorption Bands in the Spectrum of Colored Organic Fluids. By J. C. Dalton, M.D., Pamphlet, 8vo. 10 pp New York, 1874.

Gmelin-Kraut's Handbuch der Chemie Herausgegeben von Dr. Karl Kraut. Zweiter Band. Erste und Zweite Lieferung. Pamphlet, 8vo. 144 pp. Dritter Band. Elfte bis vierzehnte Lieferung. Heidelburg, 1874.

Ueber den Einfluss des Freiherrn Justus von Liebig auf die Entwicklung der Physiologie. Eine denkscrift von Dr. Theodor L. W. von Bischoff. Pamphlet, quarto. 104 pp München, 1874.

Dr. Justus Freiherrn von Liebig zum Gedächtniss. Rede von Dr. Max von Pettenkofer. Pamphlet, quarto. 50 pp. München, 1874.

Justus Freiherrn von Liebig als Begründer der Agricultur-Chemie. Eine Denkscrift von August Vogel. Pamphlet, quarto. 61 pp. München, 1874.

"Determinazione del peso specfico del Cimene di diverse provenienze, del Cumene e della Benzina di G. Pisati ed E. Paterno." Palermo, 1873, 30 pp. 8vo.

This pamphlet contains the account of a series of elaborate and careful researches on the specific gravity of cymene made from essence of cumin, from cuminic alcohol, from camphor, and from essence of thyme; also of cumene and benzine. To avoid the errors which might be caused by weighings in air, the vessel containing the hydrocarbons was counterpoised by another of the same size and weight as nearly as possible. Corrections were of course made for temperature, and the specific gravities were determined at various temperatures, the results being always duplicated, and in some cases triplicated. The results are given to six places of decimals, regarding which the authors say that they "believe them to be absolutely accurate to the fourth place, and also the fifth place merits a little confidence." The results of the other observers are quoted, and the results given are sufficiently near to show that errors if made have been extremely slight.

BREVITIES.

Dr. T. E Thorpe has been elected Professor of Chemistry in the Yorkshire College of Science, Eng.

John Ferguson has been appointed to the Chair of Chemistry in the Glasgow University.

The Chemical Society of the Cooper Union, New York.—We are pleased to learn of the foundation of this Society. At the meeting held Nov. 28th, a paper on "The Water Type" was read by Wm. Falke.

Adulteration of Beeswax.—A. W. Miller, Ph.D., has examined some samples of "refined beeswax," and found it adulterated with paraffin, one part wax to four parts paraffin By heating 100 grains of the mixture with one ounce of oil of vitriol to 350° F., for twenty minutes, the wax is carbonized, and the paraffin not affected. Water is then added, and the carbon separated from the paraffin by repeated melting.—*American Journ. Pharmacy.*

Utilization of Pine Leaves.—Pine leaves are largely utilized in Europe. They are converted into a kind of wool or wadding, which is used for upholstery instead of hair. A kind of flannel is also made from this fibre, which is said to be very superior for many hygienic uses, as for rheumatism or skin diseases. Vests, drawers, loose shirts, etc., are also made of this material. In the process of manufacture an ethereal oil is obtained, very useful as a solvent and as a curative agent. Gas is made from the refuse, and used for lighting the manufactories, or the entire refuse may be pressed in the form of bricks, when it becomes an excellent fuel.—*Am. Mfg. and Iron World.*

Determination of Caffeine.—MM. Aubert and Haase have published some results of experiments for the determination of caffeine in different preparations of coffee. The aqueous infusion is evaporated to a syrupy consistency and then treated with chloroform, which, after standing over it for a day, is removed and evaporated,

a brown residue remaining. This is treated with a small amount of ether to remove the coloring matter. Analyzing by this method it was found that the simple infusion does not leave one fifth of the caffeine behind. Coffee strongly and rapidly roasted contains as much or nearly as much caffeine as that which has been feebly roasted, but the caffeine is much more readily extracted from it. The physiological effects produced by coffee are not attributable to the caffeine exclusively.

Siliceous Lime in Sugar Refining.—The inconveniences in the use of lime containing silica in sugar manufacture are thus pointed out by M. Riffard, in the *Journal Fabricants de Sucre:* Incrustations of sometimes 2 mm. thickness are formed. The following is an analysis:—

	Incrustation of tubes.	On the bottom of the pan.
Silica	76·75	73·52
Alumina and iron oxides	4·54	2·92
Lime	7·71	4·94
Magnesia	Trace	0·05
Organic matter	10·31	17·30
	99 31	98·73

This silica is also of great injury to the black. Being in a soluble form, sugar has the property, like the inorganic acid, of extracting it. This silica is introduced as an impurity in the lime used.

Chloroform when added to crude petroleum when burning will at once extinguish it. According to F. M Ommegauck, of Antwerp, five per cent. or one-twentieth part will most readily effect this result. Even one-sixtieth part may be made to extinguish the oil when burning.

Coke saturated with liquid hydrocarbons, as naphtha, etc., has been proposed as a material for the manufacture of illuminating gas. The idea of the invention is that the hydrocarbons are readily volatilized in a state well suited for allowing them to be split up so as to become permanent gases. The invention is due to M. H. S. E. Jolly, of France.

Determination of Melting Point of Lead Alloys.—The usual method of determining the melting point of lead and tin alloys has been to place the alloy in a small tube and heat it gradually in an oil bath. According to R. Grehm, slight inaccuracies result from this method, because the surface of the alloy becomes covered with a film of oxide, which fuses at a higher temperature, and renders the observation more difficult. Even if the glass tubes are sealed up, errors may arise, because the alloys soften and become pasty before they fuse, and the particles adhere to the glass and do not run together readily until a higher temperature is reached. In certain cases, as in alloys intended for safety plugs in steam boilers, it is interesting to know the temperature at which they soften, as well as the melting point. Grehm accomplishes this very easily in the following manner: The alloy is drawn out, if possible, to a strong wire, otherwise it is rolled in thin plates, which are then cut into narrow strips. Two wires or strips are cleaned and bent into rings; one of these is suspended by a hook of iron wire, and the second suspended from this. Both rings are placed in an oil or paraffine bath and warmed. As the rings soften they stretch into ellipses, and finally become straight; but when the melting point is reached they fall to the bottom of the vessel. The following data were obtained in this way:—

Alloys. Tin.	Alloys. Lead.	Softens at deg. Fah.	Melts at deg. Fah.
2	2	365	372
2	6	372	383
2	7	377½	388
2	8	395½	406 to 410

—*The Engineer.*

Manganese in Glass-works.—It is said the solutions of manganese resulting from the manufacture of chlorine may advantageously replace peroxide of manganese in glass-works. The acid liquid is poured into a large wooden vat, which it fills to the height of one-third, and ground carbonate of lime is added. When the effervescence is over, the rose-colored solution is decanted, free from iron, which has been precipitated by the chalk. The solution is now placed in a second vat with slaked lime, so as to produce a thick mixture. This turns brown rapidly on the surface. It is dried, and calcined in contact with air till the brown color is completely developed. The residue is then ground, and washed with water to remove the chloride of calcium.—*The Engineer.*

Mr. Charles B. Dudley, who was graduated from Yale College in 1871, and who since that time has been connected in an editorial capacity with the *College Courant* (New Haven), has accepted the position of assistant to the Professor of Physics in the University of Pennsylvania—a chair now filled by Professor George F. Barker, formerly of Yale College.

Reports from the Great Butler Oil District.—The Titusville *Courier* publishes an elaborate report of the Great Butler Oil District, covering the entire production of the country south and west of Pittsburg. The figures have been collected by going over each farm and taking the records of each well in detail. The summary gives at present five hundred and ninety-six producing wells, and eighty-one wells now drilling. One thousand and seventy-six engineers are employed. The working capital invested is $1,859,000. The daily production of oil in this district is fifteen thousand five hundred and forty-eight barrels, which shows a large decrease since the first of August.

A Western farmer says in a communication that he discovered many years ago that wood could be made to last longer than iron in the ground. Time and weather, he says, seem to have no effect on it. The posts can be prepared for less than two cents apiece. This is the recipe: Take boiled linseed oil and stir into it pulverized charcoal to the consistency of paint. Put a coat of this over the timber, and, he adds, there is not a man that will live to see it rot.

An English correspondent states that a company has been formed to work the sulphur deposits at White Island, a marine volcano one hundred and forty miles from Auckland. It is estimated that one hundred thousand tons of sulphur in an almost pure state are lying on the island ready for shipment.

A Lady Chemist.—According to the report of the State Board of Health of Massachusetts, 1874, a large part of the four hundred and fifty analyses there given were performed by a lady in the laboratory of the Massachusetts Institute of Technology, Miss Ellen H. Swallow, B.Sc.

Conversion of Wood into Lignite.—In one of the old mines of the Upper Hartz, in Hanover, some of the wood originally employed in timbering has become so far altered as to assume most of the characters of a new lignite, or brown coal. Many of the levels in the ancient workings of this mine are filled with refuse matter, consisting chiefly of fragments of clay-slate, more or less saturated with mine-water, and containing here and there fragments of the old timbering. When wet, this wood is of a leathery consistence, but in the air it soon hardens, having most if not all the characters of lignite. It breaks with a conchoidal fracture, and the parts that are most altered have the black, lustrous appearance of the German "pitch coals." Chemical examination shows that this altered wood is nearer to true coal than some of the younger tertiary lignites. From all this it would appear that the transformation of vegetable matter into coal requires less time than is usually estimated by geologists; in the present instance it cannot have been over four centuries.—*Popular Scientific Monthly.*

Prices of Gas in America.—The following are the current rates for gas paid by consumers per one thousand feet:—

Albany	$2·50	Rochester	$3·50
Baltimore	2·75	St. Louis	3·25
Boston	2·50	Syracuse	3·25
Chicago	3·37½	Troy	3·25
Cleveland	2·50	Washington	3·56
Concord	3·20	Hamilton	3·00
Harlem	3·00	Kingston	3·50
Lowell	2·75	London, Canada	3·00
Manchester	2·70	Montreal	2·60
New York	2·75	Quebec	2·80
New Orleans	3·00	Toronto	2·50
Oswego	3·50		

As a good lecture experiment with potassium, in order to show the green color of the vapor of the metal, a small piece is vaporized in a wide horizontal tube, about 0·3 metre long, a current of hydrogen being passed through the tube at the same time. The tube becomes quickly filled with the beautiful green vapor, and the hydrogen which is caused to pass out through a narrow opening, takes fire spontaneously, and burns with a violet light, forming thick clouds of potassium oxide.—*The Engineer.*

Torrey Memorial Cabinet.—*United States Assay Office, Wall Street, New York.*—Sir: Having come into the possession of a small though valuable collection of American ores and minerals, the gift of my honored father, the late Dr. John Torrey, I take the liberty of addressing you regarding a plan proposed by me for the preserving the same. As Dr. Torrey occupied at his death, and for many years previous, the position of United States Assayer, I have chosen to present this, as his bequest, to the government; a gift which has been gratefully acknowledged; the government causing to be erected for its reception in the Assayer's Office, New York, commodious cases bearing the inscription "Torrey Memorial Cabinet."

Though this collection, as received and transferred by me, contains many rare and valuable specimens, it is my purpose to constitute it the nucleus of a more complete and extensive one. In order to effect this I desire to secure the aid and co-operation of American scientists and collectors. It is therefore with a view of perfecting this plan that I am prompted to address you, and request that you will bear the Torrey Memorial Cabinet in mind; and when in the possession of desirable specimens that can be spared, will forward the same to my address, to be received either as a gift or for exchange.

So convinced am I of the need and value of such a collection that a special plea seems hardly necessary. Situated in the city of New York, where it can be consulted by miners, metallurgists, and others, this collection cannot but be of great practical value, and hence any additions made to it may justly be considered in the light of a public benefit.

Trusting that you will so regard it and act favorably upon this request, I have the honor to remain

Very respectfully yours,

H. Gray Torrey,

U. S. Assayer, 32 Wall St., N. Y.

Lyceum of Natural History, in the city of New York, Chemical Section. Monday, November 9, 1874. The following papers were read: Prof. Charles A. Seeley, On the Estimation of Manganese. Prof. Henry Wurtz, Recent Investigations in Practical Gas-Analysis (*with experimental illustrations*). Dr. H. C. Bolton, Definitions of Chemistry.

THE AMERICAN CHEMIST.

Vol. V. No. 8.

SMELTING OPERATIONS OF THE TECOMA MINING AND SMELTING COMPANY, OF UTAH AND NEVADA.

BY JAMES P. CARSON, E.M.

The mines of this Company are located in Lucin Mining District, six miles south of Tecoma Station, on the C. P. R. R., and the dividing line between Utah and Nevada passes through the property.

The ores are chiefly ferruginous carbonates of lead. They are arbitrarily divided into two classes.

The first-class ores are the gray and black carbonates, assaying 45 per cent. to 70 per cent. lead and 10 ounces to 40 ounces silver; and also a fine ochreous ore, assaying 20 per cent. lead and 60 ounces to 90 ounces silver—it will vary by measure per ton from 12¼ cubic feet to 17¾ cubic feet. It is self-fluxing, and, when free from molybdates of lead, is very easily smelted with ordinary care.

The second-class ores are those poor in both silver and lead. They are very calcareous und ferruginous, containing some zinc, and as much as 30 per cent. oxide of iron. They are too basic to smelt alone, but with the addition of silica or two-thirds of first-class ore can be worked with profit. 20 cubic feet weigh one ton.

The smelter was three-quarters of a mile from the mines, and was leased, from Buel & Baltimore, at $400 per month rent. It was represented to be in perfect repair and fully equipped with tools, etc.

The tools consisted of two grindstones, a forge, six slag pots, and a few old shovels and picks.

To repair the furnace, engine, water-pipes, building, etc., and the purchase of the necessary tools, cost over $1200.

The furnace was of the Piltz pattern, with a movable tap; hexagonal outside, with iron plates at the base, and the usual iron bands around the sides; section at tuyeres 30 × 36 inches; 5 tuyeres with 2½ inch nozzles; tuyeres 10″ above the dam plate; height above tuyeres 10 feet; section at top 36″ × 36″—siphon tap.

The blast was supplied by a No. 9 Sturtevant blower, put in motion by a 10-horse portable threshing engine, which also worked a small pump, the waste water from the tuyeres being pumped back into the receiving tank.

The fuel used was Connelsville coke and charcoal. The coke cost at the works $44·08 per ton, but the waste and short weight amounted to 9·3 per cent., which made it cost $48·18.

The charcoal was of the finest description, made from nut, pine, and mountain mahogany, and weighed 19 pounds per bushel. It was delivered at the works at 23 cents per bushel, all passing through an inch fork and all brands were rejected, so that there was no appreciable waste.

It was very much regretted that charcoal could not be exclusively used, but a constant supply could not be depended on; it had to be burned during very severe winter weather, and from contracts let for 30,000 bushels, only 7000 were delivered in time. At the close of work, by great good luck, the only material on hand was 400 bushels of charcoal.

Unlike the ores near Salt Lake, a siliceous flux was needed, but the only available silica in any quantity was obtained near the railroad at $3 per ton. It was in fine sand, and was found to contain nearly as much lime as silica, and in working it increased the loss of metal by carrying off particles in the blast, and frequently rolled to the bottom of the furnace without combining with the charge, so that its use was soon abandoned.

A small quantity of quartz, containing 11 ounces of silver, from one of the adjacent mines, was obtained at $8 per ton. It worked extremely well for our purposes, but on account of the difficulty of mining and transportation, and the owners considering that it was a valuable silver ore, it was delivered only in small lots of 700 pounds or 800 pounds as a personal favor. It served as a dose for the furnace when in trouble rather than as a flux—close watching, and varying the proportions of the first and second-class ores had to be relied on for successful working—and of the latter as much was used as the furnace would stand, generally about one-third. The slags were sub-basic, and contained Pb = 4 per cent. to 11 per cent. and Ag = 0—1·2 ounce. One piece specially selected on account of its iron, with a view of selling it as an iron flux at Salt Lake, contained 18 per cent. silica and 65 per cent. iron.

On account of the economy in the first repairs to the works, the mechanical feed was left, but from the difficulty of controlling the working of the furnace, it was removed and replaced by brickwork at the first opportunity. Two of the tuyeres were also removed, with a decided advantage to the lining of the furnace and the smelting of the ore.

Report of smelting operations for seventy-five days is as follows:—

In blast	52 days.
Repairing	18 "
Delayed for ore	5 "

Consumed—

First-class ore	595 tons.
Second-class ore	296 "
Coke	115·8 "
Charcoal	9810 bushels.
Sand	13·5 tons.
Quartz	3·5 "
Assay first-class ore, lead	42 per cent.
" " " silver	34 ounces.
" second class ore, lead	25 per cent.
" " " silver	24 ounces.

Produced—

Bullion	278·6 tons.
Assay of bullion, silver	91·52 ounces.
" " gold	0·41 "
Loss of lead	14 per cent.
" silver	6·7 "

17 tons of ore were smelted in twenty-four hours, though on one occasion 23 tons were run through in the same time—one-quarter to one-half second-class ore was mixed with the first according to circumstances.

When quartz could be obtained, the daily charge was as follows :—

Reducing the coke to its equivalent amount of charcoal, assuming 1 ton coke = 200 bushels of charcoal weighing 12 pounds per bushel, then 1 ton coke = 126·3 bushels of charcoal weighing 19 pounds per bushel.

Ore	17 tons.
Quartz	0·4 to 0·5 = 17·5

Fuel consumed, coke = 0·13 T × 17 = 2·21 = 279·12 bus.
" " charcoal 11 × 17 = 187·00
" " = 466·12 bushels.
" " per ton of charge = 26·6 bu. = 505·4 lbs. = 25·27 p. c.
" " " " ore = 27·41 " = 520·8 " = 26·03 "

The daily cost of labor is as follows:—

3 smelters at $4	$12 00	
3 feeders at $3·75	11 25	
2 helpers at $3·50	7 00	
2 coal and ore wheelers at $3.75	7 50	
		$37 75

To this must be added—

1 foreman at $5	$5 00	
1 smith at $4	4 00	
2 engine drivers at $4	8 00	
2 Chinamen, breaking ore	3 50	
		20 50
Salary of manager		12 00
Total,		$70 25

Cost per ton of ore $4.13.

The cost of repairs is thus represented—

Labor	$762 50
3000 fire bricks at $120	360 00
10 tons fire rock and clay at $30	300 00
Rent, 23 days at $400 per month	316 59
Superintendent, etc., at $12 per day	276 00
	$2015 09

∴ Cost repairs per ton ore = $2 26.

Sundry expenses while running—

1·43 cords of wood for engine at $5	$7 15
Oil, tallow, and waste for engine	39
Lights and lamp-chimneys, etc.	1 60
Steel, etc.	1 00
	$10 14

17 tons ore smelted per day, cost of sundries, per ton of ore, $0.60.

Cost of smelting one ton ore—

0·13 ton coke at $48.18	$6 26
11 bushels charcoal at 25 cents	2 75
Labor	4 13
Repairs	2 26
Sundries	60
Rent of furnace $13.33 ÷ 17	78
	$16 78

From the above figures, and the uncertain supply of quartz, no attempt was made to smelt the second-class ore alone, but it was succesfully introduced into the Salt Lake market, as an "iron ore," and 450 tons were sold at a decided profit.

MISCELLANEOUS CHEMICAL NOTES.

BY S. DANA HAYES.

State Assager for Massachusetts.

X. On the Determination of Sulphur in Coal, Coke, Pyrites, Gunpowder, etc.

In a recent number of the London Chemical News, W. F. K. Stock, F.C.S., gives the following method. "One grm. of coal or coke, in fine powder, and 1 grm. of pure lime are mixed in a platinum capsule 9 c. m. in diameter, having perpendicular sides 1·3 c. m. in depth, and weighing about 30 grms.; distilled water is then added in sufficient quantity to form a thin paste of the consistency of cream, and the whole stirred with a short glass rod until the operator is sure that every particle of the fuel under examination is in perfect contact with the solution of calcium hydrate. The capsule is now heated upon a thick cast-iron plate by means of a Bunsen's burner, and as soon as the mass becomes dry, which is easily accomplished, it is stirred to a coarse powder, and heated to bright redness in a muffle for about twenty minutes, at the end of which time the whole of the carbon will have undergone combustion. The capsule is allowed to cool, and 3 c. c. of a concentrated solution of ammonium nitrate are added. In making this addition, care must be taken not to allow the solution to mix too freely with the assay, otherwise loss of substance is sure to result from the energetic action of the calcium oxide upon the ammonium salt. It is best to scrape a portion of the lime from the bottom of the platinum vessel, and to drop the solution gradually upon the bare spot by a pipette. The mass is again brought to dryness and heated to redness for five minutes, then cooled, dissolved in dilute HCl, and the sulphur determined as $BaSO_4$ in the usual manner."

A simple modification of the process just quoted has been in use here for a long time for determining sulphur with accuracy, in coal, coke, pyrites, gunpowder, etc. About a gramme of the substance to be analyzed, in fine powder, is soaked in four or five times its measure of a strong solution of pure sodium hydrate in alcohol for a few minutes in a platinum capsule; then four or five grammes of pure hydrated lime are gradually added, and the whole mass, which has about the consistency of

thick cream, is again thoroughly stirred with a strong platinum wire and without the addition of water. The other parts of the process are like those given by Mr. Stock; although in many cases sodium nitrate in fine powder may be stirred in directly with, and in place of, one-third or one-half of the lime, and thus the necessity for a subsequent ignition with ammonium nitrate is obviated.

The advantages gained by the use of the alcoholic solution of sodium hydrate in this method of analysis are important. It insures complete coating and permeation of each particle of the pulverized substances operated upon with pure soda; it facilitates the thorough mixing of the materials by stirring; and it enables the operator to heat the capsule immediately, without preliminary drying, as the alcohol burns off without any spirting or danger of loss of material.

The solutions of sodium hydrate in alcohol, and pure calcium hydrate in powder, are easily prepared, and are most useful reagents in the analytical laboratory for many purposes.

XI. An Uncommon Spring Water.

This comes from Mercer County, West Virginia, fifty or sixty miles west of the White Sulphur Springs.

It has a yellowish-brown color, sharp astringent taste, little or no odor, deposits a small proportion of brown flocculent matter after standing for several weeks, contains an excess of sulphuric acid, and its specific gravity is 1006·5.

One United States gallon, of 231 cubic inches, contained, by analysis:—

	Grains.
Chloride of sodium	2·576
Sulphate of potash	1·925
Sulphate of soda	0·564
Sulphate of magnesia	6·136
Sulphate of zinc	18·831
Persulphate of iron	168·027
Sulphate of iron	68·452
Sulphate of alumina	80·621
Silica	4·836
Phosphoric acid	traces.
Sulphuric acid	5·680
Ammonia	mere traces.
Organic matter	3·444
Total	361·092

No. 4 State Street, Boston,
December 8, 1874.

ACTION OF CHLORIDE OF LIME UPON SUGAR.

J. M. Merrick, B.Sc.

It has been proposed to use a mixture of chloride of lime and sulphate of alumina in clearing and bleaching sugar solutions preparatory to boiling down. *A priori* we might suspect that the action of hypochlorous acid would be to cut down the percentage of crystallizable sugar in a given sample—and such, in fact, is the case, as the third, and perhaps the second, experiment detailed below shows, although the sugar stands the rough handling better than I should have supposed.

I took an East Indian, very dark-colored, sugar, which by several tests polarized 83·50, for the purpose of experiment.

Experiment A. I took 32·7 grms. of the sugar dissolved in 200 c. c. of warm water, and added thereto, 1st, 2 grms. ordinary chloride of lime, and then 3 grms. of commercial sulphate of alumina. The mixture was made at 55° C., the flask thoroughly shaken and cooled as quickly as possible. Polarization gave 83·50 per cent. The color of the solution, which smelled strongly of hypochlorous acid, was much lightened by the treatment.

B. 32·7 grms. were dissolved in 200 c. c. of hot water, and 2 per cent.—·654 grm.—of chloride of lime, and then 1·30 grm. sulphate of alumina added to the solution, which was brought to 87° C. in fifteen minutes—and then cooled to 22°. The time of cooling was twenty-five minutes. This solution, upon polarization, gave 83 per cent. (strong). Its color was somewhat lightened.

C. 32·7 grms. sugar were treated as before with 4 per cent.—1·308 grm.—of chloride of lime added, with 2 grms. of sulphate of alumina. The solution was brought from above 40° C. to 87° C. in fifteen minutes—the experiment being carried on alongside A—and cooled in twenty-five minutes to 22° C. Polarization gave 82 per cent. The color of the solution was much lightened, and the smell of the hypochlorous acid was strong. Both the solutions—B and C—after filtration through bone-black, contained, as might have been expected, large amounts of chloride of aluminium and sulphate of lime. Of course, in preparing the solutions for polarizing, much sulphate of lime was caught in the charcoal, but a great deal came through. The above experiment shows that 2 per cent. of chloride of lime, at a moderate and not long-continued heat, cuts down the crystallizable sugar 1·50 per cent., and in the subsequent processes of boiling down (in the sugar-house) it must needs be that chloride of aluminium and sulphate of lime present would work still further mischief. Chloride of sodium can do vast harm to sugar upon boiling, and chloride of aluminium cannot do any less. Further, the action of these salts upon the char would be anything but desirable, and the vacuum pan would suffer.

Of course the bag filters would take out all the excess of sulphate of lime, but an injurious amount would go through in solution. Finally, even if such a process could be made safe, in very careful hands, it is doubtful whether it could be worked in a refinery when trusted to ordinary laborers.

Laboratory, 59 Broad Street, Boston,
December 23, 1874.

TABLE FOR THE CALCULATION OF RESULTS OBTAINED ON MINERAL AND POTABLE WATERS.*

BY E. WALLER, A.M., E.M.

The following table may be found of use in the analysis of mineral and potable waters for the calculation of the number of grains in the U. S. gallon of 231 cubic inches, the number of *milligrammes* per litre having been found. The number of grains in the gallon has been taken as 58,318, which is believed to be the most correct figure, though authorities on the subject differ slightly from one another, *e. g.*, the U. S. Dispensatory gives 58.328·886, or nearly 11 grains more.† Either of these results gives about 133·3 avoirdupois ounces in the gallon.

Table showing the number of grains in the U. S. gallon of 231 cubic inches, corresponding to the number of milligrammes in one litre.

Mgs. to 1 litre =	grs. to U. S. gal.	Mgs to 1 litre =	grs. to U. S. gal.
1	0·058318	37	2·157766
2	0·116636	38	2·216084
3	0·174954	39	2·274502
4	0·233272	40	2·332720
5	0·291590	41	2·391038
6	0·349908	42	2·449356
7	0·408226	43	2·507674
8	0·466544	44	2·565992
9	0·524862	45	2·624310
10	0·583180	46	2·682628
11	0·641498	47	2·740946
12	0·699816	48	2·799264
13	0·758134	49	2·857582
14	0·816452	50	2·915900
15	0·874770	51	2·974218
16	0·933088	52	3·032536
17	0·991406	53	3·090854
18	1·049724	54	3·149172
19	1·108042	55	3·207490
20	1·166360	56	3·265808
21	1·224678	57	3·324126
22	1·282996	58	3·382444
23	1·341314	59	3·440762
24	1·399632	60	3·499080
25	1·457950	61	3·557398
26	1·516268	62	3·615716
27	1·574586	63	3·674034
28	1·632904	64	3·732352
29	1·691222	65	3·790670
30	1·749540	66	3·848988
31	1·807858	67	3·907306
32	1·866176	68	3·965624
33	1·924494	69	4·023942
34	1·982812	70	4·082260
35	2·041130	71	4·140578
36	2·099448	72	4·198896
73	4·257214	87	5·073666
74	4·315532	88	5·131984
75	4·373850	89	5·190302
76	4·432168	90	5·248620
77	4·490486	91	5·306938
78	4·548804	92	5·365256
79	4·607122	93	5·423574
80	4·665440	94	5·481892
81	4·723758	95	5·540210
82	4·782076	96	5·598528
83	4·840394	97	5·656846
84	4·898712	98	5·715164
85	4·957030	99	5·773482
86	5·015348	100	5·831800

* Copies of this table, printed on a separate sheet, may be obtained gratis by application to the American Chemist.

† See discussion of this point by W. H. Chandler, Am. Chem. I. 318.

PRIESTLEYANA.

BY H. C. BOLTON, PH.D.

The recent celebrations at Northumberland and Birmingham of the centenary of the discovery of oxygen by Dr. Priestley brought out many curious incidents in his career and numberless anecdotes; we select the following as characteristic.

While he was a minister at Leeds a poor woman who labored under the delusion that she was possessed by a devil applied to him to take away the evil spirit which tormented her. The doctor attentively listened to her statement and endeavored to convince her that she was mistaken. All his efforts proving unavailing, he desired her to call the next day, and in the mean time he would consider her case. On the morrow the unhappy woman was punctual in her attendance. His electrical apparatus being in readiness, with great gravity he desired the woman to stand upon the stool with glass legs, at the same time putting into her hand a brass chain connected with the conductor, and having charged her plentifully with electricity he told her very seriously to take particular notice of what he did. He then took up a discharger and applied it to her arm, when the escape of the electricity gave her a pretty strong shock. "There," said she, "the devil's gone; I saw him go off in that blue flame, and he gave me such a jerk as he went off! I have at last got rid of him, and I am now quite comfortable."

The destruction of Dr. Priestley's house and laboratory, by the riotous mob, at Birmingham in 1791, proved most disastrous, and the maddened crowd met with little opposition. "There was a small attempt by a few people to drive off the rabble, but they were compelled to show their heels by a shower of brickbats." The following amusing doggerel poem which was published at the time, refers to this incident—

The famous Dr. Priestley
Though he preached to admiration,
Yet he never could persuade
The unruly cavalcade
Not to show their detestation.

They burned down both the meetings,
His manuscripts and papers.
And they swore it in their wrath
That they would not leave him worth
A single farthing taper.

His house and all the utensils,
Out-offices and stable;
Nor durst the doctor stay,
But prudently got away,
And rejoiced that he was able.

The following epitaph, having reference to Dr. Priestley's peculiar religious views, was composed before his death by Rev. David Davis, one of the wits of the time. Dr. Priestley is said to have laughed heartily over it.

Here lie at rest
In oaken chest
Together packed most nicely,
The bones and brains
Flesh blood and veins
And *soul* of Dr. Priestley.

CONTRIBUTIONS TO THE THEORY OF SOLUBILITY.

BY ISIDOR WALZ, PH.D.

In the following paper I beg to submit some general remarks on the subject of solution and solubility, and an attempt to trace some relations between the solubility of substances, their specific volume, and chemical constitution.

I. *Nature and Classification of Solutions. Relation of Solution to Chemical Action.*

Until a comparatively recent time the solution of a substance in a liquid was considered as a phenomenon analogous to the fusion of such substance by itself, and the change in temperature by which the former is often attended was also explained by reference to the latter. Lately, however, we find the opinion pretty generally sustained, that solution is the result of the motion of molecules and the action of molecular forces. This is nowhere stated more clearly and emphatically than by Dossios,* who propounded a theory of solutions based on the mechanical theory of heat, the object of which was "to demonstrate the distinction between the forces that come into play in the formation of chemical compounds, and in solutions, and to show that the latter is identical with molecular force," and "that only by assuming the action of molecular force in the case of solutions, the attendant phenomena, as well as the thermal effects and the boiling points, may be explained in an unconstrained manner."

In another direction, also, views have somewhat changed lately, namely as regards classes of phenomena that should be considered under the head of solution. Formerly the term was confined to the solution of solids in liquids, and to the mixture of liquids which only dissolve in each other in certain proportions. The *Handwoerterbuch*, of Liebig, Poggendorff, and Woehler, as late as 1858, recognizes no other cases of solution, and says distinctly (vol. 2, p. 549), "When two liquids mingle in every proportion, we do not call this a solution, but a mixture." It is, therefore, a very great enlargement of the field when, five years later, we find Kopp* grouping together, under the designation of "*chemical* combinations in variable proportions," the solutions of solids in liquids, the mixtures of all liquids, the absorption of gases in liquids, and the combination of solids with solids, as in the case of alloys, and pointing out properties and laws common to them all. It will be noticed that he regards all their combinations as the results of chemical action, a view which has yielded to more mechanical notions at present; and Dossios, in the above-mentioned paper, restricts the term solution to the solution of solids, liquids, and gases in liquids, the resultant being in all cases a liquid. There seems to be no good reason, however, why we should make such a restriction. If we assume that solution is the result of molecular force, that it consists mainly in the penetration of the molecules of one substance into the intramolecular spaces of another,† and their retention there, we must disregard the physical state of either substance, and study the manifestations of that force under all circumstances, if we would hope to find a clue to its nature, or to some general law. We must not forget that the physical state of a "substance is a fortuitous attribute, not an essential one, such as, for example, its molecular structure. If the average temperature were 100° C. higher or lower than it really is, circumstances in which water, our principal and representative solvent, would be either a gaseous or a solid substance, what would become of the subject of solution if studied under such an arbitrary and restricted definition? What would become of chemistry, if we would take into account only the compounds formed in reactions 'by the wet way,' and reject those 'by the dry way?'" The following general definitions may, therefore, be given: "Solution is the penetration of the molecules of one or more substances into the intramolecular spaces of another substance, and the consequent formation of a homogeneous resultant." "A solution is an homogeneous aggregate of dissimilar molecules, whose attraction for each other is equal to or greater than that of the similar molecules."

Under these definitions we have five distinct classes of solutions, viz.:—

1. Of solids in liquids, including the amalgams.
2. Of liquids in liquids, whether miscible in all, or only in limited, proportions.
3. Of gases in liquids, embracing all cases of *absorption* of gases in liquids.

* Vierteljahrschrift d. Naturforsch. Gesellsch. in Zürich, 1868.

* Kopp, Theoret. Chemie, 1863, p. 20, et seq.

† For brevity's sake I shall use the term *solvent* for one of the substances co-operating in the formation of a solution, and the term *solute* for the other.

4. Of solids in solids, including the alloys.

5. Of gases in solids, including absorption of gases by porous solids, diffusion of gases through metals, and occlusion of gases by the same.

I have omitted the mixture of gases, because, though their mixture is effected by the penetration of the molecules of one with the intramolecular spaces of another, the molecules are not retained in those spaces by the attraction of the dissimilar atoms, or any other molecular force.

These various classes of solution have many characteristics in common. In all of them we find the solvent generally retaining its physical state, and imposing it, as it were, upon the solute. Whether a liquid dissolves a solid, a liquid, or a gas, the resultant solution is still a liquid; and, in a similar manner, the molecular combination of a solid with a gas or another solid is still a solid. In this respect they differ from chemical compounds whose physical state is entirely unrelated to the physical states of their components.

One of the principal agencies in bringing about solution is diffusion. This is obvious in the solution of gases in liquids and in solids, and of liquids and solids in liquids. The solution of solids in solids is only a special form of solution of solids or liquids in liquids, for their molecular mixture is only accomplished when one or both are in the liquid or molten condition.

Among the characteristic phenomena of solution is the displacement of the boiling point when the resultant is a liquid, or of the melting point when the resultant is a solid. Such displacement takes place in all of the five classes of solution.

The agencies by which solutions may be broken up, and their ingredients separated from each other, operate in a similar manner on the various classes whenever the nature of the case admits of their application. These agencies are principally alterations of temperature and molecular or chemical forces of greater intensity than the molecular forces which effected the solution.

1. Heat destroys the solution of solids in liquids, including amalgams, by volatilizing the liquid. The solution of liquids in liquids is broken up and the liquids separated by fractional distillation. By the application of heat gases are expelled from solution in liquids as well as solids. Solutions of solids in solids may be disintegrated by the application of heat, especially when some of the constituents are more volatile than others, as in the processes of cupellation. Cold, which is a change of temperature in the opposite direction, can, in the nature of the case, be applied destructively only to liquid solutions, and generally breaks them up when one of the ingredients solidifies at a lower temperature than the other, *e. g.*, solutions of gases in water, of fats in alcohol or petroleum oils, etc. etc.

2. Among the forces of greater intensity than those concerned in forming solutions, chemical action may be named as that applicable to nearly every class of solutions. Water solutions of solids are destroyed by placing them in a confined space with concentrated sulphuric acid, fused calcium chloride, or other powerful absorbents. Solutions of gases may be broken up in a similar manner, by confining them together with chemical absorbents, such as caustic alkalies for carbonic acid, acid for ammonia, etc. The same method is applicable to many cases of solutions of liquids in liquids, and solutions of solids in solids may be attacked with chemicals, able to remove and separate the ingredients from each other.

Again, we may vary the pressure under which the solution exists. By creating a vacuum over it, we may disintegrate the solutions of gases in solids and liquids, while by increased pressure solids are in a number of instances precipitated from their liquid solvents.

These considerations seem to be sufficiently conclusive to warrant the inclusion of all the phenomena embraced in the five categories, mentioned above, under the general term *solution*, and to support the opinion that they are brought about by the action of the same molecular force or forces.

A very simple relation exists between solution, hydration, and chemical action, according to this view. Let us assume a molecule A of any solvent substance which has penetrated into the space between the molecules of water. The position of A in reference to nH, in which n denotes any number above 1, may be one of the following three, or it may occupy all three in succession:—

1. The molecule A may be situated equidistantly from the molecules H, H, H, etc., and the distance between A and each of the molecules of water may be so great that the molecular attraction is just sufficient to retain A in its position, and no more. Such relations are the conditions of solution pure and simple.

2. The mutual attraction of the molecules A and the molecules H, H, H, may be or may become (as, *e. g.*, by heat) so great, that A will be drawn and retained closer to the single molecule H or the molecules nH than it was in the former case, and yet not sufficiently close to enable either kind of molecules to exert a disturbing influence on the internal atomic structure of the other. These are the conditions under which hydrates are formed in aqueous solutions, and of which the crystallizing out of hydrated salts is only a special form.

3. The mutual attraction of the molecules A and the molecules H or nH may be or become so great, and these molecules may approach each other so closely, that the atomic structure of each is disturbed and broken up, and the atoms composing each may re-arrange themselves so as to form new molecular systems, which are more stable in close proximity to each other than those which they superseded. Under these conditions the molecules of solvent and solute act chemically upon each other.

There are so many substances which, when dissolved in water, exhibit these phenomena in succession, that it is unnecessary to dwell upon them at length; I would, however, cite a few instances which at first sight appear anomalous. The anhydrous chlorides of arsenic, anti-

mony, silicon, etc., are in reality very soluble substances. They absorb moisture from the atmosphere, deliquesce, and undergo solution and hydration almost simultaneously. When sufficient water has been attracted, they form crystalline hydrates; but if still more water is presented to them, the conditions for chemical action are given, and the corresponding oxides or oxychlorides are formed. The chlorides of calcium, magnesium, aluminium, iron, and other metals show the same phenomena under somewhat different conditions, the last stage—chemical reaction—being in their case brought about, *e. g.*, by the application of varying degrees of heat. Thus, while ferric chloride may be "dissociated" into ferric oxide and HCl by simply applying heat to its aqueous solution, a much higher temperature is required to produce a similar reaction in the hydrated chlorides of calcium and magnesium.*

Adopting, then, this extended view of solution, by which it is made to include the molecular intermixture of solids also, we obtain the general law, that "*solution is a necessary condition precedent of chemical action,*" whether such action is brought about by the wet or by the dry way.

From this simple view of solution, the conclusion naturally follows that *the size of the molecules and intermolecular spaces, in other words, the specific volume of a substance, must have an important influence in determining the solubility of substances*, and I shall endeavor to demonstrate this in the second portion of this paper. Before entering on this part of the subject, a few remarks on solubility and insolubility may be permitted; special reference being had, as throughout, to water, when no other solvent is mentioned.

Strictly speaking, we ought to distinguish a sixth class of solutions, in addition to the five enumerated above, namely, that of liquids in solids. There are many substances which are but little soluble in water, yet able to dissolve a large amount of the latter. The resultant in these cases is frequently, however, neither in the liquid nor in the solid state, but in a pasty or gelatinous intermediate condition. Such substance are, *e.g.*, silica, magnesium oxide, albumen, starch, gelatine, and similar mucilaginous and colloid compounds. In them the cohesion of the similar molecules is so great, that it is not overcome even by a very large number of dissimilar molecules penetrating into their intermolecular spaces. This great internal cohesion of their molecules is also manifested in all of them, by their inability to pass through the pores of a membrane when they are subjected to dialysis. When these substances are brought into contact with water, they increase very largely in volume, by reason of the great amount of it which they absorb and dissolve; at the same time a small quantity of them passes into true aqueous solution. Thus we see that of two substances, A and B, A may be a solvent of B, and B of A, but in a very different degree. Given a small quantity of A and a sufficiently large one of B, B will dissolve all of A; if the conditions are reversed, A will dissolve all of B, and under intermediate conditions two solutions will be formed, one of A in B, and one of B in A,* always calling that ingredient to a solution the *solvent* which retains its physical condition, and imposes it, as it were, upon the other.

Solutions of this class, then, are broken up by the same agencies as the others, viz., higher temperature and the action of molecular and chemical forces of greater intensity than those which effected the solution (desiccation, dialysis, etc.). It may be interesting to examine a few cases more closely.

Anhydrous stannic or titanic acid is dissolved by concentrated sulphuric acid to a syrupy mass, *i. e.*, the molecules of sulphuric acid penetrate between those of stannic and titanic acid, and weaken the internal cohesion of their molecular systems to such an extent that the resultant becomes a semi-liquid mass. If water be added to this, the superior attraction of its molecules to those of sulphuric acid comes into play, and prevails; the sulphuric acid diffuses from its solution with the acids mentioned into the water, the molecules of stannic or titanic acid are again free to follow their natural attraction to each other; they are precipitated as insoluble powders. As in this case there is no chemical affinity between the sulphuric acid and SnO_2 or TiO_2 to aid the solution, it seems to present the phenomena of solution and precipitation in a very simple form.† There is no reason to believe, however, that the process is essentially different when chemical action is possible between solvent, solute, and precipitant, as solution is the condition precedent of chemical action; though the two may be so closely consecutive in time as to appear almost simultaneous, and the striking effects of chemical action overshadow the simpler effects of solution. The solution of alumina in acids, and its precipitation by alkalies, and hundreds of similar cases, may be explained in the same manner as the case first cited, by the principles of molecular mechanics, though the formation of the various salts accompanying these processes belongs to a different order of phenomena.‡

* Another very interesting case in point is that of chlorine. Chlorine dissolves in water and forms a hydrate which crystallizes out—$Cl_2,_{10}H_2O$—when the solution is cooled to about 1° C. A solution of chlorine is decomposed even at average temperatures according to the formula $Cl_2 + H_2O = 2HCl + O$. Bromine behaves in an exactly similar manner.

* The case of ether and water, when brought into contact, is somewhat similar.

† A very similar case is that of an aqueous solution of cobalt chloride to which alcohol is added. This mixture has a red color when cold, showing that part of the water, at least, is dissolved in the salt; but on heating, the affinity of water for the alcohol preponderates, and the color turns to the blue of the *anhydrous* cobalt chloride.

‡ The transition of a substance from the liquid to the solid state in the midst of a liquid, which we call precipitation, is not a sudden but a gradual one; though in many instances the intermediate stages escape our observation, we are able to trace them in numerous others. Thus silica may be separated as a transparent, colorless jelly, as a pasty, flocculent mass, or as a fine white powder. In a similar manner calcium carbonate may be obtained either as a transparent gelatinous, a flocculent, or a crystalline precipitate. Many similar instances readily suggest themselves.

The precipitation of substances soluble in alcohol but insoluble in water (such as fats, oils, and a number of salts), by the addition of water, and *vice versa;* the removal of substances dissolved in ether, carbon disulphide, the hydrocarbons, etc., by agitation with the suitable aqueous solvents, are entirely analogous phenomena. Even such "dissociations" as that of ferric chloride in a heated aqueous solution may be explained on this principle. We have only to assume, that, under ordinary circumstances, the attraction of the molecules of water for those of hydrochloric acid is equal to that of the attraction of the molecules of the acid for those of ferric oxide, thus insuring a true solution, while at higher temperatures the attraction of the former kinds of molecules is greater than that of the latter, or, what amounts to the same thing, that at higher temperatures the attraction of the molecules of ferric oxide for each other is gradually increased. The tendency of salts of ferric oxide to form insoluble basic salts when their solutions are heated, would seem to strengthen this view.*

We have now reached a point at which the mechanical and chemical reactions of the molecules become so closely associated that it is almost impossible to keep them apart, and to assign to each its due share in bringing about observed phenomena, even if such an attempt could be successful at all in the present condition of atomechanics. The two orders of phenomena shade off into each other by insensible gradations, and reflection upon them leads to the strong belief that chemical phenomena will find their explanation by atomic forces, closely analogous to the molecular forces which underlie the phenomena of solution, and that we shall then dispense with the notion of that hypothetical special force, *chemical affinity*.†

As yet, we have no unit by which solubility may be measured, and no means of designating the degree of solubility of any substance with anything like the precision demanded in physics, with the exception of the solution of gases in liquids, in which case the ascertained coefficients of absorption answer the requirement. Of all other substances we only predicate that they are soluble or insoluble, and express the intermediate degrees of solubility by such vague terms as very, quite, little, sparingly soluble, and similar generalities. It is customary to state the number of parts of water in which one part of substance is soluble at given temperatures, or the number of parts of substance which dissolve in water at certain degrees of heat. It would seem to be more rational and more likely to lead to the discovery of general principles to adopt the molecular weight of the solute expressed in grammes or parts as a basis of comparison, instead of one part of it; or the molecular weight of the solvent, expressed in grammes or parts of the solvent instead of the arbitrary standard of 100 parts.

II. *Relations between the Solubility of Substances and their Specific Volumes.*

If the reasoning that has led us to the supposition of a relation between the solubility and the specific volumes of substances is correct, we may expect to find—

1. That there exists a relation between the solvent powers and the specific volumes of different solvents.

2. That the solvent power of one and the same solvent varies with its specific volume.

3. That the solubility of a solute in one and the same solvent varies with its specific volume.

4. That in a series of similarly constituted substances, such as the chlorides, sulphates, sulphides, etc., the solubility of the members of the series varies with their specific volumes.

1. *Relation between Solvent Power and Specific Volume of different Solvents.*—For reasons mentioned above, solutions of gases are best adapted for such a comparison of the solvent power of different solvents. If we compare the coefficients of absorption of the permanent gases in water and alcohol, as determined by Bunsen, and the specific volumes of water and alcohol, we find a very remarkable coincidence.

Water: molecular weight = 18; sp. gr. (at 4° C.) = 1; specific volume = 18.

Alcohol: molecular weight = 46; sp. gr. (at 0° C.) = ·7946; specific volume = 57·7.

Ratio of spec. vol. of water and alcohol: 18 : 57·7 = 1 : 3·2.

Coefficients of absorption (at 0° C. and 766 mm.) of—

Hydrogen in water = 0·0193; in alcohol 0·96925; ratio 1 : 3·5.

Nitrogen " " = 0·020346; in alcohol 0·126338; ratio 1 : 6·2.

Oxygen " " = 0·04115; in alcohol 0·2825; ratio 1 : 6·8

Carbon monoxide in water = 0·032874; in alcohol 0·20443; ratio 1 : 6·2.

* Prof. Leeds, of the Stevens Institute, has photographed a precipitate of nickel tungstate, formed by adding nickel chloride to ammonia tungstate, the solutions being left undisturbed for a long time. The appearance of the precipitate suggests strikingly that of a mass striving to concentrate, as it were, upon itself.

† It is a striking fact that in the more prominent of recent textbooks the term *affinity* is scarcely as much as even mentioned, and this is hardly to be wondered at, considering the condition of the subject. Formerly chemical affinity was defined as the force which effected the union of dissimilar atoms. Subsequently it was found necessary to introduce the notion of molecular affinity; and finally, if we wish to explain consistently the existence of such molecules as those of the elements in the free state (Cl_2, H_2, O_2, etc.), it would seem necessary to assume a kind of chemical affinity which effects the union of similar atoms, which is an absurdity.

The term *affinity* has recently been used in a quasi quantitative manner for the power of an atom of combining with a varying number of other atoms, the "affinity" for hydrogen being taken as the unit for comparison. Thus, we speak of uni-, bi-, triaffine, etc., atoms. Whether the affinity of an atom is assumed to be constant, as by one school of theoretical chemists, or variable, as taught by another, it seems to be tacitly agreed by all that the affinity or valency of an atom is a characteristic of *the atom taken by itself*, and as peculiar to it as its specific gravity, or its size and shape. But, it seems to me, that the facts connected with atomic valency are less easily explained by the theory that it is inherent in the atom, than that it is a *state of the atom which is induced in it by juxtaposition with dissimilar atoms*. The affinity of O for H, Cl, etc., according to this view, does not pre-exist in the O atom, but is induced in it, at the moment when it comes into sufficiently close proximity to the other atoms, and the "affinity" thus induced varies according to the nature, quantity, temperature, etc., of the atoms brought together. Much in the same manner in which currents of electricity of very different intensity are generated if we connect zinc with copper, or zinc with platinum, chemical energies of very different strength are developed when atoms of oxygen come into contact with those of H, Cl, etc.

Thus, we see that the *solubility of hydrogen in water and alcohol is directly proportional to the specific volumes of these solvents; and that of oxygen, nitrogen, and carbon monoxide to a simple multiple of the ratio of the specific volumes of the solvents.* The coefficients of absorption of the condensible gases show less simple relations, as is to be expected; but they are all greater for alcohol than for water, or, in other words, greater for the solvent with the greater specific volume. The lowest ratio is that of carbon dioxide, whose coefficient of absorption at normal temperature and pressure is: in water, 1·7967; in alcohol, 4·32955; ratio = 1 : 2·41.

The ratio of the coefficients of absorption in water and alcohol for sulphur dioxide, obtained in the same manner, is 4·09; and for sulphuretted hydrogen 4·11. Between these numbers, 2·4, 3·2, 4·09, or 4·11 exists the simple relation 3, 4, 5, so that, although the solubility in the case of these condensible gases is modified by the introduction of chemical influences, such modifications stand in a simple relation to the specific volumes of the solvent.

I am not aware of the existence of other series of quantitative data which could be made the subject of similar comparison. In their absence we find qualitative proof of the truth of the principle which we are discussing in the solubility of most of the fats, oils, etc., which are soluble in alcohol, but insoluble in water. These substances, possessing high molecular weights and low specific gravities, have consequently very large specific volumes; thus tristearin ($C_{57}H_{110}O_6$), *e. g.*, in one of its modifications has the molecular weight 890, specific gravity at 65° C. 0·9245; and, therefore, the specific volume 963. It will be shown hereafter that the specific volumes of such very soluble substances in water as $CaCl_2$, SO_4H_2, K_2S, and others lie between 50 and 54; it would seem natural, therefore, to conclude that the insolubility in water of the molecules of fats and oils is due, partly at least, to the fact that their specific volumes are disproportionately large compared with that of water; they cannot penetrate into the intermolecular spaces of the latter, and therefore float on its surface, while they are able to dissolve in alcohol, the specific volume of which is more than three times greater than that of water. They are, therefore, still more soluble in solvents with still larger specific volumes, such as carbon disulphide, ether, oil of turpentine, etc., of which we give the data below.

	Formula.	Molecular weight.	Specific gravity.	Specific volume.
Carbon disulphide .	CS_2	76	1·293 at 0° C.	58·7
Ether	$C_4H_{10}O$	74	0·735 " " "	100·6
Oil of turpentine .	$C_{10}H_1$	136	0·89 " " "	152·8

Having considered the relative solubilities of substances which combine high molecular weights with low specific gravities, and which possess, in consequence, very high specific volumes, let us turn to the opposite class, which are endowed with very large molecular weights, high specific gravities, and small specific volumes, such as $PbSO_4$, AgCl, and others. While the former class float, insoluble, on water, the latter fall through it and collect, or remain insoluble at the bottom, exactly as a piece of light wood dropped on a net would remain on it or would be caught in the meshes, if of proper size and form, while a piece of lead, iron, etc., of the same size and form as the wood, would fall through, breaking the filaments if not strong enough to withstand the impact. But while these substances are insoluble in water, solvents with large specific volumes are in many cases able to dissolve them. Thus, tin dioxide, titanium dioxide, etc., are soluble in strong sulphuric acid; mercury dissolves a number of the metals; many of the heavy metallic oxides are soluble in caustic alkalies, etc.

The question may be asked, why, under this explanation, should not alcohol, with a specific volume of 57·7, act in the same manner on lead sulphate, for example, as SO_4H_2, the specific volume of which is 53·26; in other words, why should there be such a vast difference between the action of two solvents, the specific volumes of which do not differ very much, as to constitute one preeminently a solvent for large and light molecules, and the other for small and heavy molecules, leaving for the moment the difference of chemical structure and composition out of view? We shall not receive a clear and perfect answer to this question till we shall know more of molecular mechanics and shall succeed in separating specific volume into the two factors of which it is composed. The specific volume of solids and liquids, obtained by dividing the molecular weight by the specific gravity, does not represent the space actually occupied by a molecule, but that space *plus* a proportionate part of the intermolecular space which surrounds it. What the ratio between these two components of the specific volume is in the various molecular systems and at varying temperatures, we have, at present, no means of ascertaining, though such a knowledge would be of the greatest importance and value in interpreting the phenomena of solubility. For the present we must be satisfied with pointing out, that, given, *e. g.*, two solvents like alcohol and sulphuric acid, the respective molecular weights of which are 46 and 98, and the specific volumes 53·2 and 57·7, it is evident that the acid molecule contains very nearly twice as much matter in the same space as the alcohol molecule, which circumstance must make a material difference in the nature of their solvent action.

From these considerations, then, we deduce the conclusions, that *the solvent power of solvents, considered in regard to one and the same solute, is a function of their specific volumes;* and for equal specific volumes a function of their molecular weights.

2. *Variation of the Solvent Power and Specific Volume of a Solvent.*—Under this head we have to consider principally the influence of temperature on solvents. The specific gravity of substances is decreased by heat, and, as the molecular weight remains unchanged, the specific volume, which is the ratio of the two, becomes proportionately larger, and we find, also,

as a general rule, that the solvent powers of substances are enhanced by higher temperatures. In fact, in many cases of solutions of all classes, solution only becomes possible when the specific volume of the solvent has been enlarged to a certain extent by the application of heat. Cases in point are the absorption of oxygen by melted silver, the occlusion of hydrogen by red-hot iron and other metals, the formation of alloys by fusion, and numerous others that readily suggest themselves. As a general rule, therefore, *the solvent power of a substance increases directly with its specific volume.*

3. *The Solubility of a Solute Varies with its Specific Volume.*—There is a limitation to the regularity noted under the previous head, however, owing to the fact that we have to consider not only the increase by heat of the specific volume of the solvent, but also that of the solute. If the specific volumes of both increase in the same ratio, the increase of solubility will be directly proportional to the increase of temperature. This regular increase of the solubility with the temperature is presented, *e. g.*, by potassium chloride and barium chloride (as shown by the well-known graphic representation of solubilities which is found in many of the text-books), and it is a curious coincidence that the solubility of these two salts in water is very nearly alike, and that their specific volumes and that of water show a very simple relation, viz.:—

H_2O,	molec. weight, 18;	spec. grav. 1;	specific vol. 18.		
KCl,	" " 74·6;	" " 1·944;	" " 38·3 (Mean of 9.)		
$BaCl_2$,	" " 208;	" " 3·855;	specific vol. 53·9 (Mean of 8.)		

or very nearly the ratio 1, 2, 3.

If, on the other hand, the specific volume of the solute increases under the influence of temperature at a more rapid rate than that of the solvent, the solubility will increase much more rapidly than the temperature; and this is actually the case in most instances of salts dissolved in water. It might seem, at first sight, very unlikely, that the specific volume of a molecule of a solid saline substance should increase more rapidly under the influence of heat than the molecule of an elastic fluid, like water; but it must be remembered that, when salts dissolve in water, the specific volume of their molecules is very considerably enlarged by their forming a molecular combination with a part of the water, and that we must deal with these hydrated molecules. When, as in the case of sodium sulphate, the saline molecule, at a certain temperature, becomes unable to retain its molecular connection with the water of hydration, and, in consequence, a reduction of specific volume takes place, we find this phenomenon attended with a corresponding reduction of solubility. Below 33° C. the solubility of Glauber's salt increases much more rapidly than the temperature; above 33° C. the anhydrous salt is in solution, and as the expansion of the saline molecule by heat must be assumed to be very small compared to that of the molecule of water, the attraction of the similar molecules begins to preponderate, and further increase of temperature is attended with an actual though slight decrease of solubility. The specific volumes of Glauber's salt and anhydrous sodium sulphate are, respectively—

Na_2SO_4	molec. weight, 142;	sp. gr. 2·64;	spec. vol. 53·78 (Mean of 12.)	
$Na_2SO_4 + 10H_2O$	" " 322;	" 1·45;	spec. vol. 222·0 (Mean of 8.)	

It is not improbable that the greater solubility of other salts, such as lanthanum and didymium sulphates, calcium butyrate and citrate, etc., in cold than in hot water, is to be explained, in the same manner, viz., that they are capable of forming hydrates at a lower temperature, but that at higher temperatures they exist in solution as anhydrous salts. The specific volume of the saline molecule being but slightly increased by heat, while that of the water molecule increases very rapidly under the same circumstances, the ratio of the specific volumes becomes greatly different from that which conditioned the initial solubility, and a decrease of the latter takes place in consequence.

In sodium chloride we possess another salt which exists in the anhydrous state in aqueous solution, the specific volume of which is consequently but little affected by variation of temperature; and the increase of its solubility between 0° and 100° C. is, therefore, but slight. It is analogous to sodium sulphate also in another respect, for Rüdorff* has shown that it exists in solutions as $NaCl + 2H_2O$ below 9° C., while above this point it is dissolved as anhydrous NaCl.

In the cases which we have just considered the variation of the specific volume of the solute takes place in the solution itself; but a variation of the specific volume of the solute, *before it is dissolved*, is also attended by a corresponding change of its solubility. Thus, sulphur exists in three allotropic modifications, which differ in specific gravity, and consequently in specific volume, from each other. The difference of their behavior to solvents like carbon disulphide, potassium bisulphite, etc., is well known. Phosphorus with its three allotropic modifications offers another illustration. The allotropic modifications of silicic acid, stannic acid, alumina, ferric oxide, and numerous other substances, and their different behavior to alkaline, acid, and other solvents, may also be instanced.

4. *Relations of solubility and specific volume of substances of analogous composition.*

In order to verify the supposition that there might be a relation between the solubility and specific volume of substances, I have calculated the specific volumes of several series of compounds, and in order to avoid any subjective bias in the selection of the data in cases where different specific gravities had been found by different observers, I took the specific gravities as given in the "Constants of Nature," by F. W. Clarke, recently published by the Smithsonian Institution, and where a

* Rüdorff, Pogg. Annal. 1861, 114, 63; 1862, 116, 55 (as cited by L. Meyer).

number of specific gravities were found attributed to the same substance, I took the mean of all, except in some instances in which a manifestly erroneous determination was not taken into account.* The results are tabulated below:—

Sulphides.

Formula.	Molec. weight.	Spec. grav.†	Spec. vol.		
CoS	90·7	5·45	16·64	Soluble in acids.	Insoluble in water.
NiS	90·7	5·12	17·71		
FeS	88	4·835	18·40		
MnS	87	4·00	21·75		
CuS	95·5	4·199	22·50		
ZnS	97·2	4·017	24·19		
PtS	229·5	8·847	25·94	Insoluble in acids.	
HgS	232	8·039	28·86		
CdS	144	4·67	30·83		
PbS	239	7·488	31·91		
Na_2S	78	2·471	31·56	Soluble in water.	
Ag_2S	248	7·204	34·42		
SnS_2	182	4·507	40·38		
K_2S	110	2.130	51·64		
Tl_2S	440	8·00	55·00		
CS_2	76	1·2484	60·87	Insoluble in water, soluble in alkalies & alkaline sulphides.	
Bi_2S_3	516	7·357	70·13		
As_2S_3	246	3·45	71·24		
Sb_2S_3	340	4·499	75·57		

Although the specific gravities attributed to one and the same sulphide by different observers differ sometimes very largely, sometimes by as much as 1, although the determinations for the different compounds have sometimes been made at temperatures so widely apart that strict comparison is out of the question, and although for many of these compounds the specific gravities are known only with approximate accuracy,—and these considerations are true for the following tables also,—the table of normal sulphides, as given above, shows some interesting regularities. The sulphides with the highest and lowest specific volumes are insoluble in water, while the specific volumes of the soluble sulphides stand midway between them, thus showing that solubility depends, to a great extent, on the relation of the specific volumes of solvent and solute. The sulphides insoluble in strong acids, the sulphides soluble in acids, the sulphides soluble in water, the sulphides soluble in alkaline sulphides, fall together almost into regular groups, when arranged according to their specific volumes, as in the above table.

There are some exceptions to this regularity; but in this we recognize the operation of another principle alluded to before, namely, that for substances of approximately equal specific volumes, the solubility is a function of the molecular weight. Thus, Ag_2S, molecular weight 248, and spec. vol. 34·42, is about three times as dense as Na_2S, mol. weight 78, and spec. vol. 31·56. The one is soluble in water, the other insoluble. Bi_2S_3, S_3, and As_2S_3 are of nearly equal specific volumes; but the molecular weight of the former is more than twice that of the latter. The one is soluble in alkaline sulphides, while the other is not.

It is remarkable that CS_2, though in some respects so totally unlike the other sulphides cited, has certain properties analogous to those of the group of sulphides with which it is associated by its specific volume. Like arsenic and antimony sulphide, it is insoluble in water, but soluble in alkalies and alkaline sulphides, and capable of forming the "double sulphides" with the latter. We may trace a further analogy between its liquid condition and the ready fusibility of As_2S_3 and Sb_2S_3, and between its volatility and that of As_2S_3 at higher temperatures. All these considerations, moreover, hold good when we compare it with realgar As_2S_3, the specific volume of which is very nearly the same as that of CS_2, viz., 61·14 (mol. weight 214; spec. grav. 3·5). These and similar facts, with which we shall become acquainted, point to relations between the specific volume and physical properties of substances other than their solubility, with which we are at present principally concerned.

In the above table tin disulphide has an abnormal position. We should expect to find it after CS_2, which would bring the well-known group of As_2S_3, Sb_2S_3, and SnS_2 together, and cause the table of sulphides to show a further regularity, as the members of the typical groups M″S, M'_2S, $M''''S_2$, and M'''_2S_3 would be grouped together according to their specific volume; a regularity shown in the most decided manner when the specific volumes of the normal chlorides are tabulated. Further investigations will undoubtedly rectify or explain this anomaly.

Chlorides.

Formula.	Molec. weight.	Spec. grav.	Spec. vol.	
LiCl	42·5	2·036	20·87	I.
AgCl	143·5	5·4599	26·28	
NaCl	58·5	2·154	27·15	
HCl	36·5	1·27[1]	28·74	
[CuCl]	99	3·526	28·07	
[HgCl]	235·5	6·891	34·17	
[TlCl]	239·5	7·01	34·16	
KCl	74·6	1·944	38·37	
$*HgCl_2$	271	6·233	43·54	II.
$*MgCl_2$	95	2·177	43·64	
$*CuCl_2$	134·5	3·054	44·04	
$*CoCl_2$	129·7	2·937	44·16	
$ZnCl_2$	136	2·753	49·40	
$CaCl_2$	111	2·241	49·53	
$PbCl_2$	278	5·58	49·82	
$FeCl_2$	127	2·528	50·23	
$CdCl_2$	183	3·625	50·47	
$NiCl_2$	129·7	2·56	50·66	
$MnCl_2$	126	2·478	50·74	
$HgCl_2$	271	5·301[2]	51·01	
$[CrCl_3]$	158·7	3·03	52·37	⋮
$[VCl_3]$	157·8	3·00	52·60	⋮
$[TlCl_3]$	310·5	5·9	52·62	⋮
$BaCl_2$	208	3·855	53·95	⋮
$SrCl_2$	158·5	2·881	55·01	⋮

* I may be permitted to state that most of these calculations were made and the results compared in the fall of 1873, but not published, owing to the difficulty I encountered in collecting the necessary data regarding specific gravities, of which I was relieved by the appearance of Clarke's valuable tables, when I revised my previous calculations. While engaged on the first series of calculations, I observed the isosterism of certain chlorides and other compounds, to which Dr. H. Schroeder has recently drawn attention in the *Ann. de Chem.* (vols. 173 and 174), and recognized the relation between certain physical properties and the specific volume.

† The specific gravities under this column in the following tables are the means of those given in Clarke's work.

[1] Liquid.

[2] Mean of all except Playfair and Joule's determinations.

Formula.	Molec. weight.	Spec. grav.	Spec. vol.	
$BiCl_3$	316·5	4·56	69·42	III.
NCl_3	120·5	1·653	78·94	III.
$AsCl_3$	181·5	2·204	82·35	III.
$SbCl_3$	228·5	2·675	85·42	III.
BCl_3	117·5	1·35	87·03	III.
PCl_3	137·5	1·55	88·70	III.
CCl_4	154	1·60	96·25	IV.
$TiCl_4$	192	1·76	109·09	IV.
$SiCl_4$	170	1·52	111·84	IV.
$SnCl_4$	260	2·24	116·07	IV.

In this table we find the analogously constituted chlorides ($M'Cl, M''Cl_2, M'''Cl_3$, etc.) coming together in groups when arranged in the order of their specific volumes. As the same regularity appeared in the table of sulphides, we are justified in assuming a relation between the atomic structure and the specific volumes of these compounds; and this may perhaps be applied as an aid in determining the correct molecular formula of a substance.

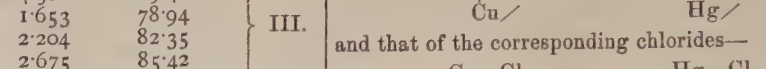
In this table we do not find the same regularity with regard to solubility as in the table of sulphides. It begins with the most deliquescent salt known, lithium chloride, and ends with silicium and tin tetrachloride, which are also deliquescent and soluble in water.* Though the degree of solubility varies considerably between these limits, it may be pointed out that among the *normal* chlorides — by which I understand the *highest* chloride any element can form—there is only one, silver chloride, which can be called absolutely insoluble, and that the tendency of chlorides is toward solubility in water, while among the sulphides it is toward insolubility. We shall find certain regularities, however, if we examine the different groups separately.

In the first group we have only three normal chlorides—LiCl, NaCl, and KCl—that can be compared as to solubility; for hydrochloric acid, being a gas under ordinary circumstances, must be left out of account. For these the solubility seems to decrease in inverse proportion to the specific volume; NaCl at 0° C. is more soluble than KCl, 100 parts of water at 0° C. dissolving about 85 parts of the former and only 29 of the latter. In this group we find AgCl of almost the same specific volume as NaCl, though its molecular weight is 2½ times greater; and the corresponding difference in solubility again illustrates a principle which we have repeatedly pointed out.

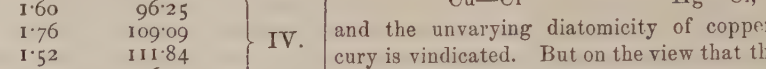
I have placed in this group, in brackets, the lower chlorides of copper, mercury, and thallium, though to the first two the doubled formulas Cu_2Cl_2 and Hg_2Cl_2 are generally assigned. These formulas, however, have no better basis than the theory that the "valency" or "atomicity" of an element is constant and invariable, and the consequent necessity of constructing such formulas for the lower chlorides, oxides, etc., that the metals shall still appear divalent.

Hence the structure of Cu_2O and Hg_2O is assumed to be—

and that of the corresponding chlorides—



and the unvarying diatomicity of copper and mercury is vindicated. But on the view that the atomicity of an element is variable, we may assume that Cu and Hg are monads in the lower and dyads in the higher series of their compounds, just as we must assume carbon as a tetrad in CO_2, and as a dyad in CO. According to this view the structural formula for cuprous and mercurous chloride and oxide become—



These formulas have been adopted by many chemists, and I would cite, as additional confirmation of their correctness, *the near coincidence of the specific volumes of these four most insoluble of all chlorides*, AgCl, CuCl, HgCl, *and* TlCl, if these formulas are adopted. If we write Cu_2Cl_2 and Hg_2Cl_2, their specific volumes become 56·14 and 68·34 respectively, and their positions in the above table would become utterly anomalous.

If we adopt these formulas, it might seem as if the *solubility of the members of this group was inversely* proportional to the molecular weight of the chlorides (or *to the atomic weight of their metallic elements*), viz.:—

HCl	. .	molecular weight 36·5
LiCl	. .	" 42·5
NaCl	. .	" 58·5
KCl	. .	" 74·6
CuCl	. .	" 99·
AgCl	. .	" 143·5
HgCl	. .	" 235·5
TlCl	. .	" 74·6

But, although, in groups of similarly constituted bodies, whose specific volumes do not differ much, the molecular weight, undoubtedly, determines the solubility, as we have already seen in a number of instances, and shall continue to find, it must be borne in mind that from the above list RbCl (molecular weight 120·9), and CsCl (molecular weight 168·5) are necessarily omitted, as their specific gravities have not yet been determined, and their insertion would destroy this seeming regularity; for we know that they are more soluble than KCl. For the present we are, therefore, compelled to assume two groups, one containing KCl, RbCl, and CsCl, in which the solubility increases directly as the molecular weight, and another in which the solubility decreases with increasing molecular weight. The metals of the first series have proportionately much lower specific gravities and higher specific volumes than those of the second, a fact which is probably closely connected with the different variation of the solubility of their chlorides within the two series.

In the next group, which embraces the dichlorides,

* See observations on p. 281.

we find a much greater regularity. With regard to $MgCl_2$, $CuCl_2$, and $CoCl_2$, which are marked with asterisks, the only determinations of specific gravity accessible are those made by Playfair and Joule, and as their determinations are in many other cases much higher than those found by other observers, and seem in fact to have been affected by some uniform error, we may well assume that this anomaly is only apparent and will disappear when their specific gravity shall be better ascertained. If, *e.g.*, the specific volume of $HgCl_2$ is calculated from the specific gravity found by Playfair and Joule, it takes its place with the three chlorides named; but if the mean of five other determinations is taken, its specific volume becomes 51·01, which is very nearly the normal specific volume of the dichlorides. Omitting then the three chlorides mentioned, because the specific volumes are not sufficiently determined, we find eight out of ten dichlorides whose specific volumes fall within 49·40 and 51, forming a remarkable *isosteric** group, with a mean specific volume 50·2, of which all members but one are most readily soluble, and even deliquescent; besides, they are all easily soluble in alcohol. Alongside of this series $PbCl_2$, $BaCl_2$, and $SrCl_2$ seem to form a side-group in which the solubility increases with the specific volume of the members, lead chloride being the least and strontium chloride the most soluble of the three. The members of this series differ also from those of the other in that $PbCl_2$ and $BaCl_2$ are insoluble, $SrCl_2$ difficultly soluble in absolute alcohol.

Assuming, for reasons stated before in the case of HgCl and CuCl, the formula $CrCl_3$, we have next another isosteric group $TlCl_3$, $CrCl_3$, and VCl_3. The two latter are especially interesting. They have nearly identical molecular weight, specific gravity, and specific volume; and connected with these is a most remarkable similarity of physical characteristics, such as color, crystalline form, solubility, etc.

In the higher groups, 3 and 4, the regularity is less striking, partly perhaps because their specific gravities are less definitely known, and perhaps because all the members are liquids (or gases, like BCl_3, $SiCl_4$), and the specific volumes, calculated from the specific gravities at ordinary temperatures, yield less conformable and comparable results than if they would be compared at temperatures near their boiling points. Probably we ought to separate the group also into two series, like the lower ones, viz.: $BiCl_3$, $AsCl_3$, $SbCl_3$; and NCl_3, BCl_3, PCl_3. Yet we find the group of trichlorides definitely separated from that of the tetrachlorides. We also find, connected with these higher specific volumes, as a rule quite ready solubility in alcohol, ether, benzine, and other organic solvents, volatility and deliquescence, coupled with decomposition, when they come into contact with a larger quantity of water, into oxides or oxychlorides of the metals on the one hand, and hydrochloric acid on the other. I may point, out in this connection, that the members of the first group, including $PbCl_2$ of the second, are anhydrous, and those that are soluble in water are left behind as anhydrous chlorides when their aqueous solution is evaporated; the members of the second group form crystallized hydrates when their aqueous solution is evaporated, and, if the heat is carried further, tend to decompose according to the formula $M''Cl_2 + H_2O = M''O + 2HCl$. In the third and fourth group this tendency to chemical decomposition with water is still more strongly and decidedly marked, taking place, as it does, already at ordinary temperature; CCl_4 forms, however, an exception to this general statement.

Altogether, the higher chlorides with their comparatively high molecular weights and low specific gravities, taken in connection with their ready solubility in the lighter organic solvents, form good illustrations of the principles of the relation of the specific volumes of solvent and solute as discussed on p. 283.

The bromides and iodides show similar regularities as the chlorides; but the tables are much less complete at present, the specific gravities far less numerously and accurately determined, and the comparison of the specific volumes, therefore, less reliable.

Bromides.

Formula.	Mol. weight.	Sp. gr.	Sp. vol.
AgBr	188	6·389	29·42
[CuBr]	143·5	4·72	32·52
NaBr	103	3·014	38·02
[HgBr]	280	7·307	38·31
KBr	119	2·592	45·91
$PbBr_2$	367	6·62	55·43
$CdBr_2$	272	4·811	56·53
$CaBr_2$	200	3·32	60·24
$HgBr_2$	360	5·920	60·88
$ZnBr_2$	225·2	3·643	61·81
$SrBr_2$	247·5	3·962	62·49
$BaBr_2$	297	4·23	70·21
$BiBr_3$	450	5·604	80·29
$AsBr_3$	315	3·66 at 15° C.	86·06
BBr_3	251	2·69 (liquid)	93·30
$SbBr_3$	362	3·641 at 90° C.	99.42
PBr_3	311	2·925 at 0° C.	106·32
$SiBr_4$	348	2·812 at 0° C.	123·78
$SnBr_4$	438	3·322 at 39° C.	131·91
$TiBr_4$	370	2·6	142·30

Iodides.

Formula.	Mol. weight.	Sp. gr.	Sp vol.
AgI	235	5·551	42·33
[HgI]	327	7·697	42·48
[CuI]	190·5	4·41	43·19
NaI	150	3·45	44·11
KI	166	3·02	54·96
ZnI_2	319·2	4·696	67·97
SrI_2	314·5	4·415	71·23
HgI_2	454	6·19	73·34
PbI_2	461	6·158	74·85

* As Schroeder has anticipated me in publishing his discovery of this isosteric series, I beg to state that I discovered it in October, 1873, and addressed a note to Dr. Bolton on the subject on the 13th of that month.

Formula.	Mol. weight.	Sp. gr.	Sp. vol.
BaI_2	391	4·917	79·92
CdI_2	366	4·576	79·98
SbI_3	503	5·01 at 10° C.	100·39
AsI_3	456	4·39 at 13° C.	103·87
BiI_3	591	5·652 at 10° C.	104·56
SnI_4	626	4·696	133·30

The specific volumes of the oxides show certain regularities when the oxides of analogous constitution are placed together in groups, as in the following tables:—

Oxides.

Formula.		Molecular weight.	Spec. gravity.	Spec. volume.	
MO	GlO	25·3	3·05	8·29	Readily soluble in ammonia. Insoluble in water.
	MgO	40	3·592	11·12	
	NiO	74·7	6·314	11·83	
	CuO	79·5	6·361	12·49	
	CoO	74·7	5·673	13·16	
	UO	136	10·15	13·39	
	MnO	71	5·065	14·02	
	ZnO	81·2	5·594	14·51	
	CdO	128	8·149†	15·71	
	CaO	56	3·173	17·64	Almost isosteric; solubility inversely related to the molec. weight.
	HgO	216	11·159	19·35	
	SrO	103·5	4·27	24·23	Same as above.
	PbO	227	9·147	24·81	
	BaO	153	5·00	30·60	Most soluble oxide of this series.
M_2O	Na_2O	62	2·805	22·10	Series very incomplete. The solubility of oxides, that are nearly isosteric, is intimately related to the molec. weight.
	$[Cu_2O]$	143	5·897	27·34	
	Ag_2O	232	7·198	32·23	
	$[Hg_2O]$	416	10·69	38·91	
	K_2O	94	2·656	39·08	
	N_2O	44	0·937 (at 0° C.)	46·95	
M_2O_3	Al_2O_3	102·8	3·927	26·17	Soluble in potassa & soda. Insoluble in water.
	Cr_2O_3	152·4	5 or potassa & soda.	30·41	
	Co_2O_3	165·4	5·34	30·97	Close agreement of specific volumes; probable isosterism.
	Fe_2O_3	160	5·149	31·07	
	V_2O_3	150·6	4·72	31·90	
	Mn_2O_3*	158	4·786	33·01	
	Ni_2O_3	165·4	4·83‡	34·24	
	Mn_2O_3	158	4·61§	36·44	
	B_2O_3	70	1·794	39·01	Solubility in water, alkalies, and alcohol decreases, as molecular weight, specific gravity, and specific volume increase.
	As_2O_3	198	3·756	50·05	
	Sb_2O_3	292	5·354	54·53	
	Bi_2O_3	468	8·304	56·29	
MO_2	MnO_2	87	4·876	17·84	A probably isosteric group. Insoluble in water.
	SnO_2	150	6·659	22·53	
	MoO_2	128	5·67	22·57	
	ZrO_2	121·6	5·193	23·23	
	SiO_2	60	2·475	24·24	
	PbO_2	239	8·91	25·70	
	NO_2	46	1·305	32·05	Condensible gases; readily soluble in water.
	SO_2	64	1·4318‖	44·64	
	CO_2	44	0·9471¶	46·45	
MO_3	CrO_3	100·2	2·715	36·90	Isosteric group; solubility decreases as the molec. weight increases.
	MoO_3	144	3·6	36·92	
	WO_3	232	6·515	35·61	

* As Braunite. † Average of 2.
‡ Playfair and Joule's determination rejected.
§ Mean of all determinations.
‖ At 0·25° C. D'Andréeff. ¶ At 0° C. D'Andréeff.

Formula.		Mol. wt.	Sp. gr.	Sp. vol.	
M_2O_5	Sb_2O_5	324	6·525*	49·65	Solubility in water increases with the specific volume.
	V_2O_5	182·6	3·49	52·29	
	As_2O_5	230	3·998	57·53	
	P_2O_5	142	2·387	59·48	
	I_2O_5	334	4·487	74·43	

I abstain from further remarks on this table, beyond those I have made at the margin; else the relation between other physical properties besides that of solubility, and the specific volume might, in many instances, be traced.

The data for the comparison of other salts, at present accessible, are too imperfect for purposes of comparison, but I believe that enough has been shown to render it highly probable that the solubility and some other properties of substances are, to a certain extent, functions of their specific volumes and molecular weights.†

III. *Relations between Chemical Constitution and Solubility of Substances.*

From the views of solution which we have adopted, it follows that not only the *size* of the molecules and intermolecular spaces, or, in other words, the specific volume, is influential in determining solubility, but that their *form* also must, to a certain extent, exert an important influence. Though we know nothing in the last instance of the form and shape of the molecules, which, in their turn, naturally determine the shape and form of the intermolecular space, there is every reason to believe that they are largely determined by the atomic structure of the molecules. The phenomena of isomorphism teach us that substances, which have a similar or analogous atomic constitution frequently have the same crystalline form, though they may differ widely in chemical composition. There are numerous instances of isomerism, on the other hand, which prove that the crystalline form of substances, having the same chemical composition, may differ according to the different arrangement of the components of the molecule. It would appear justifiable, therefore, to seek in similar or analogous atomic structure of solvents and solutes, and, consequently, in similarity of the form of their molecules and intermolecular spaces, the explanation of many cases of solution, which have long ago compelled the recognition of the principle that "like dissolves like." Among the innumerable cases which might be cited here, I would refer to the solubility of the insoluble oxides, chlorides, iodides, bromides, sulphides, cya-

* Playfair and Joule's determination thrown out.

† It is a peculiar coincidence that the specific volumes of a number of substances which are exceedingly soluble in water, though differing greatly in chemical composition and physical properties, are found between 50 and 60, and not very far apart, *e. g.*—

The remarkable group of isosteric chlorides,

$ZnCl_2$, $CaCl_2$, etc.	mean specific vol.	50·2
K_2S		51·64
H_2SO_4	specific vol.	53·26
KI	" "	54·96
Alcohol	" "	57·7
As_2O_5	" "	57·53
P_2O_5	" "	59·48
$CaBr_2$	" "	60·24

nides, etc. in the corresponding soluble compounds of the alkaline metals, the solubility of organic compounds such as fats, oils, carburetted hydrogens in similarly constituted organic solvents, etc. These considerations seem to be applicable even to the so-called elements themselves and to point to a similarity of the ultimate structure of their atoms. Thus, the metals dissolve in each other, forming alloys and amalgams; boron dissolves in aluminum, with which it is probably isomorphous, and phosphorus in lead, with which it is also isomorphous; carbon and silicon dissolve in iron, aluminum, etc., with which they are isomorphous.*

The influence of both specific volume and similar chemical constitution in determining the solubility of substances, can, it seems to me, be very clearly shown by a comparison of the solvent action of water and alcohol on series of analogously constituted substances, such as the fatty acids and alcohols.

The structural formula of water is HOH. In the fatty alcohols one of the hydrogen atoms is replaced by the organic radical C_nH_{2n+1}, and in the fatty acids by the radical $C_nH_{2n-1}O$. The hydroxyl group appears to determine the solubility in water and the analogously constituted caustic alkalies. As we rise higher in the series, however, the influence of the hydroxyl group is neutralized by the increasing influence of the organic radical; amylic alcohol and valerianic acid are only difficultly soluble in water; the higher members of both the alcohol and acid series are insoluble in water, but still soluble in caustic alkalies, which are constituted analogously to water, but possess greater specific gravity and higher specific volume; and soluble in alcohol, which is constituted analogously to themselves, though the highest members of the series are less soluble therein than the lower ones. In connection with these facts, it should be remembered, that, in the series of fatty acids, the specific gravity decreases as we rise in the series; and as the molecular weight increases, it follows that the specific volume increases proportionately. In the alcohol series we find the specific gravity varying but little with the increment of molecular weight, and we find, therefore, a smaller but none the less decided increase in the specific volume of the higher over the lower members. In the series which we have discussed, there is only one "water-rest" or hydroxyl group, while the organic radical with which it is connected grows progressively larger, and the solubility in water diminishes accordingly. We may, however, construct a series in which the organic radical remains constant, or nearly so, while the number of hydroxyl groups increases, and in such a series we shall find the solubility in water increasing accordingly. We may compare, *e. g.*, the principal acids containing four carbon atoms, viz.:—

$*C_4H_7O.OH$.	Butyric acid. Oily liquid, soluble in water, alcohol, and ether. Salts separate it from a watery solution as an oily stratum.
$C_4H_5O.OH$.	Crotonic acid. Oily liquid, soluble in water, but separated from it by the addition of salts. Soluble in alcohol and ether.
$C_4H_4O_2.(OH)_2$.	Succinic acid. Pretty easily soluble in water, difficultly soluble in cold alcohol and ether.
$C_4H_2O_2.(OH)_4$.	Tartaric acid. Easily soluble in water and alcohol, insoluble in ether.

Among inorganic compounds we have the series of hydrates of the elements corresponding to the series of fatty alcohols, the elements taking the place of the organic radical. In these hydrates, however, the solubility seems to be determined not so much by the *number* of hydroxyls combined with the element, as by the *firmness of their union*, measured by the degree of heat necessary to dissociate them into anhydrous oxides on the one hand, and water on the other. Such soluble hydrates as those of the alkaline metals, SO_4H_2, H_3PO_4, ClO_4H, and others, cannot be thus dissociated by any degree of heat; the less soluble hydrates of the alkaline metals still require a very high temperature to effect the dissociation; while the insoluble hydrates of silicon, iron, aluminum, etc. are dehydrated at much lower temperatures.

As another instance of the influence of chemical constitution on the solubility of substances, the fact may perhaps be cited *that explosive compounds*, such as nitrogen chloride and iodide, potassium carbide, the compounds of acetylene with copper and silver, the fulminates, the picrates, nitroglycerin and other nitrocompounds, *as a rule, are difficultly soluble or insoluble in water.*

These few instances indicating some connection between chemical constitution and solubility may suffice for the present, as I hope to be able to resume the subject and present it more fully at some future time.

RESEARCHES UPON SOLUBLE PHOSPHATES FOR AGRICULTURAL PURPOSES.

BY M. A. MILLOT.

Translated by J. M. Merrick, B.Sc.

In the manufacture of soluble phosphates, called superphosphates, a part of the phosphate rendered soluble by sulphuric acid sometimes becomes insoluble during the drying of the product. The phosphoric acid which has become insoluble receives the name of *reduced* or reverted phosphate [*i. e.*, the lime-salt is so called. J. M. M.]. It is to-day generally admitted that this reduced phosphate is bicalcic phosphate, produced by several distinct reactions.

1. Action of the phosphoric acid set at liberty upon the unattacked tricalcic phosphate.

* It has been noticed as remarkable that the substances most frequently found in graphite as it occurs in nature, viz., SiO_2, Al_2O_3, Fe_2O_3, TiO_2, and Cr_2O_3 (which are *dissolved* in it?), crystallize, like graphite, in the hexagonal system.

* The formulas, as thus written, are, of course, not meant to express any theoretical views as to the constitution of these acids, but mainly to show the number of hydroxyls in the formula.

2. Action of phosphoric acid upon the carbonate of lime which has escaped the attack of the sulphuric acid.

3. Decomposition of the acid phosphate of lime during drying into bicalcic phosphate and free phosphoric acid.

A. The first reaction was pointed out in 1865, by M. Piccard,* of Bale. He attacked tricalcic phosphate with one equivalent of weak sulphuric acid, and obtained an acid phosphate of lime, which, left in contact with the unattacked phosphate, is transformed into crystallized bicalcic phosphate.

B. M. Joulie repeated the same experiment with tricalcic phosphate, and a weak solution of phosphoric acid. He also obtained crystallized bicalcic phosphate.

C. M. Kolbe has announced that, even at ordinary temperatures, even in the presence of an excess of tricalcic phosphate, phosphoric acid only produces monocalcic phosphate.

I have undertaken a series of researches upon this subject, and have employed phosphate of lime, nearly pure, containing neither carbonate of lime nor sesquioxides.

In attacking one equivalent of tricalcic phosphate with three equivalents of sulphuric acid, I obtained a pasty mass, entirely soluble, and which neither dried in the air nor changed its composition. This is the phosphoric acid in a paste of plaster. With 2 equivalents of sulphuric acid and water enough to make a pasty mass and to hinder a too high elevation of temperature, I obtained, after cooling, for each 100 of phosphoric acid 96·63 parts soluble, and 3·37 insoluble. After complete exhaustion with water, the insoluble residue, upon analysis, proved to be unattacked tricalcic phosphate.

I let the product dry in the open air until the weight became constant; it then contained—

Soluble phosphoric acid . . .	98·61
Insoluble " " . . .	1·39

Drying at 100° did not sensibly modify these results. The insoluble part was unmodified tricalcic phosphate. The free phosphoric acid diminished during the drying without disappearing completely. [So in the original. J. M. M.]

I then treated the same phosphate with one equivalent of weak sulphuric acid. After cooling I obtained for each 100 parts of phosphoric acid used—

Soluble	48·717
Insoluble	52·283

The insoluble part was tricalcic phosphate.

After complete drying I found—

Soluble phosphoric acid . . .	44·66
Insoluble " " . . .	55·34

After drying at 100° I obtained—

Soluble phosphoric acid . . .	43·50
Insoluble " " . . .	56·50

The insoluble residue was a mixture of bi- and tricalcic phosphates.

After drying there was no free phosphoric acid in the soluble part. There was, in fact, a slight excess of lime in proportion to the sulphuric and soluble phosphoric acids. This excess comes, doubtless, from the solubility of bicalcic phosphate in saline liquors.

On digesting the dry product in a little water, the retrogression became every day more considerable, by the slow attack upon the tricalcic phosphate of the acid by the acid phosphate of lime in solution; and crystallized bicalcic phosphate was formed, as M. Piccard has shown. We see that there is no formation of bicalcic phosphate in the dry product, except when the sulphuric acid is deficient, and that there is no free phosphoric acid. In these conditions the reversion is always accompanied by a corresponding augmentation of the lime rendered insoluble. This reaction can be explained in two different ways: either by the action of the acid phosphate of lime upon the tricalcic phosphate, or by the decomposition of the acid phosphate itself.

Phosphoric acid set at liberty will attack anew the tricalcic phosphate to form acid phosphate of lime. This seems to me probable, for the reaction is produced only in an incomplete manner in the absence of water; at least it is plain that the thick plaster mechanically hinders the action of the acid phosphate of lime upon the tricalcic phosphate. This is not the case in the phosphates of commerce, in which the sulphuric acid is always present in quantity more than sufficient to transform the tricalcic into acid phosphate.

With the phosphorite of Logrosan, containing as impurities only silica and some carbonate of lime, the same experiments have not led to exactly the same results. Employing 2 equivalents of sulphuric acid to 1 of tricalcic phosphate, there was less soluble phosphate after the action than in the preceding case; but the gain in soluble phosphoric acid after drying was considerable.

With 1 equivalent of sulphuric acid there was still an increase in the soluble phosphoric acid after drying, and the insoluble residue consisted of unattacked tricalcic phosphate. There remained always an excess of free soluble phosphoric acid, much more considerable than in the case of the treatment of the pure phosphate, which results from the difficulty of attacking the powder of apatite with weak acid.

I have indicated as one of the causes of reversion the attack upon the carbonate of lime left intact the first day of the manufacture, by the free phosphoric acid, and the [consequent] formation of bicalcic phosphate. We never find, in fact, carbonate of lime in dry superphosphates. I have found that 1 equivalent of tricalcic phosphate treated with 3 of sulphuric acid, and then, after cooling, ground with one equivalent of carbonate of lime, gives, after complete drying, an entirely soluble product of acid phosphate of lime. If, in place of letting the mass dry, it be digested with a considerable quantity of water, crystallized bicalcic phosphate is formed, as indicated by MM. Pelouze and Dumas. In superphosphates the quantity of carbonate of lime unattacked is generally very trifling, and can only give acid phosphate during the drying.

The partial decomposition of acid phosphate into bicalcic phosphate and free phosphoric acid has been pointed out by M. Joulie as one of the causes of reversion. In fact pure acid phosphate of lime decomposes during drying, and, I believe, as I have said above, that to this cause we must attribute at least a part of the reversion produced in consequence of the incomplete treatment of the pure tricalcic phosphate by sulphuric acid. I have never been able to prove this decomposition in the presence of a small quantity of free phosphoric acid, which is the case in all the commercial superphosphates; we never find an increase of insoluble lime in the dry products.

I believe that we can deduce from these experiments the fact that we must look in other quarters than in the formation of bicalcic phosphate for the reversion that is proved in superphosphates when the sulphuric acid is

* Pol. Zeitschrift. Bolley à Zurich.

in sufficient quantity or in excess. I have never seen it occur in this case except when the primitive phosphates contained sesquioxides, iron, aluminum, or manganese. There are formed in these conditions, under the influence of free phosphoric acid sesquioxide phosphates, which I propose to describe, and whose insolubility in water, and great solubility in different saline solutions have caused to be confounded with bicalcic phosphate. —*Comptes Rendus.*

RESEARCHES ON CONIFERINE; ARTIFICIAL FORMATION OF THE AROMATIC PRINCIPLE OF VANILLA.

BY MM. F. TIEMANN AND W. HAARMANN.

Translated by Josephine Chevalier.

There is contained in the cambium of coniferæ a magnificently crystallized glucoside coniferine, discovered by M. Hartig, and which was studied more recently by M. Kubel, who represents it by the following formula:—

$$C_{24}H_{32}O_{12} + 3H_2O.$$

A closer examination of this substance led the authors to represent the molecule of coniferine by the expression—

$$C_{16}H_{22}O_8 + 2H_2O,$$

the value of which coincides very nearly with the figures exacted by M. Kubel's formula.

Subjected to the action of a ferment, emulsin for instance, coniferine divides into glucose and a compound crystallized in beautiful prisms, which melt at 73°.

The latter substance is readily soluble in ether, less soluble in alcohol, almost insoluble in water. It contains—

$$C_{10}H_{12}O_3.$$

The reaction is represented by the following equation:—

$$C_{16}H_{22}O_8 + H_2O = C_6H_{12}O_6 + C_{10}H_{12}O_3.$$

Under the influence of oxidizing agents, the product of fermentation undergoes a most remarkable metamorphosis; by heating it with a mixture of potassium bichromate and sulphuric acid, ethylic aldehyde is first formed, then an acid substance, soluble in water, which can be removed by agitation with ether; by evaporating the ether, star-like groups of crystals are obtained, which melt at 81°.

These crystals have the savor and odor of vanilla. On comparative examination it was found that they were identical with the aromatic principle of vanilla, which is frequently observed on vanilla pods in the form of delicate needle-shaped crystals.

According to their analysis the body obtained by oxidation contained—

$$C_8H_8O_3,$$

exactly the composition which the recent researches of M. Carles attribute to the aromatic principle of vanilla.

The transformation of the product of fermentation into vanilline is represented by the following equation:—

$$C_{10}H_{12}O_3 + O = C_2H_4O + C_8H_8O_3.$$

In order to dispel any doubt that might exist in regard to the perfect identity of artificial vanilline with the natural product, the authors prepared, with the aid of the first, a series of salts of the general formula—

$$C_8H_7MO_3;$$

and two produced by substitution—

$$C_8H_7BO_3, \text{ and } C_8H_7IO_3,$$

which M. Carles studied, also starting with the natural body.

To unveil the nature of vanilline, it was melted with caustic soda. The product of this action was an acid well known, the discovery of which we owe to M. Strecker; it was protocatechuic acid (oxysalicylic acid) $C_7H_6O_4$, and this is the way in which it is formed:—

$$C_8H_8O_3 + O_4 = C_7H_6O_4 + H_2O + CO_2.$$

This substance has been identified by analysis and by the study of its reactions, and by transforming it into protocatechin (oxyphenic acid),

$$C_6H_6O_2,$$

which is formed by the separation of a molecule of carbonic anhydride—

$$C_7H_6O_4 = C_6H_6O_2 + CO_2.$$

Its conversion into protocatechuic acid fixes the constitution of vanilline. It is a compound of methylic aldehyde and protocatechuic acid, the molecule of which, referred to benzol, is expressed by the following formula:—

$$C_6H_3\begin{cases}OCH_3\\OH\\COH.\end{cases}$$

And, indeed, when subjected to the action of hydrochloric acid under pressure, vanilline divides into methylic chloride and protocatechuic aldehyde—

$$C_6H_3\begin{cases}OCH_3\\OH\\COH\end{cases} + HCl = CH_3Cl + C_6H_3\begin{cases}OH\\OH\\COH.\end{cases}$$

An analogous reaction takes place with hydriodic acid, in which case the aldehyde is very much changed. They obtained another proof of the tenability of their views by treating vanilline with acetic anhydride and benzol chloride. The prolonged action of these agents only produced—

$$C_6H_3\begin{cases}OCH_3\\OC_2H_3O\\COH\end{cases}; \qquad C_6H_3\begin{cases}OCH_3\\OC_7H_5O\\COH\end{cases};$$

an unexceptional demonstration that the molecule of vanilline encloses only one hydroxylic group.

The constitution of vanilline having been elucidated, there can be no more doubts on the structure of the product of fermentation, the oxidation of which engendered vanilline. The product is ethylic ether of vanilline—

$$C_6H_3\begin{cases}OCH_3\\OC_2H.\\COH\end{cases}$$

This formula explains the evolution of ethylic aldehyde during fermentation of vanilline. Besides, here is an unquestionable confirmation of these views; by treating the product of fermentation under pressure with hydriodic acid, notable quantities of alcoholic iodides are obtained, which can be separated by convenient means into methylic and ethylic iodides—

$$C_6H_3\begin{cases}OCH_3\\OC_2H_5\\COH\end{cases} + HI = CH_3I + C_2H_5O + C_6H_3\begin{cases}OH\\COH.\end{cases}$$

—*Ann. Chim. et Phys.*

EXTINCTION OF PETROLEUM BY CHLOROFORM.

BY C. OMMEGANCK.

Translated and Condensed by H. Carrington Bolton, Ph.D.

In pursuing some investigations on the diathermancy of various liquids, the author of the following communication discovered that chloroform possesses the remarkable property of extinguishing burning petroleum.

The diathermancy of iodine dissolved in carbon disulphide, or in potassium iodide being imperfect, and their use attended with certain inconveniences, the author was led to employ a solution of iodine in chloroform mentioned by several writers. In Wurtz's Dictionary, under the article chloroform, it is stated that this liquid burns under special conditions, and an attempt to verify these circumstances led to the discovery named.

Pure chloroform, absolutely free from alcohol, does not of itself burn under any circumstances, and mixed with inflammable liquids removes entirely their inflammability.

When one volume of chloroform is mixed with five volumes of petroleum, the later loses completely its property of taking fire in the ordinary ways.

This may be illustrated by the following experiment: Pour a litre of petroleum into a flat dish of such size that the liquid forms a layer about one centimetre in thickness (a pan ten dcm. by thirty-three cm. suffices), and set fire to the hydrocarbons. After the combustion has become active pour suddenly over the surface about fifty c. c. of chloroform, when the petroleum will be immediately extinguished.

In this experiment the proportion of the two liquids is one to twenty; it may be reduced even to one to sixty, or more.

If the quantity of petroleum be doubled or tripled, the result will be the same provided the same amount of surface be maintained. On attempting to relight the petroleum, the burning match is extinguished at the moment of reaching the surface of the liquid.

Inflammable vapors and gases mixed with the vapor of chloroform also lose their inflammability, and consequently their liability to explode.

The article in Wurtz's Dictionary states that a tuft of cotton saturated with chloroform burns with a green flame; this has been tried in vain, for even on placing the cotton thus saturated in the flame of an alcohol lamp, the later becomes darkened with smoke, while fumes of hydrochloric acid are evolved. . . . . If the vapor of boiling chloroform is projected into the flame of an alcohol lamp, the latter is extinguished as soon as the vapor of chloroform is abundant.*

These phenomena are not at all surprising if we consider the composition of chloroform; since the chlorine and the hydrogen form hydrochloric acid at a red heat, and the carbon set free in form of lampblack, being impregnated with these acid vapors, is not inflammable.

As a practical conclusion to the preceding, we may, with some reason, conjecture that chloroform may be used to extinguish conflagrations of petroleum. Thus a warehouse or a vessel might be provided with a hermetically sealed vessel containing chloroform, and in case of fire its intensity might be overcome at the moment of its outbreak by a minimum quantity of chloroform. The high price of chloroform seems the most serious obstacle to its employment in this manner; the article would not, however, require to be of great purity. Possibly the tetrachloride of carbon obtained by the action of chlorine on iodo-sulphide of carbon, may produce the same effect, and this could be obtained at a moderate price if manufactured on a large scale.

* Note by the translator.—In Watt's Dictionary, we find the following statement: "Chloroform cannot be set on fire in the air, not even with the aid of a wick, but its vapor passed into the flame of a spirit lamp burns with smoke." Fowne's Chemistry (1873) states that "Chloroform is difficult to kindle, and burns with a greenish flame"

UTILIZATION OF WASTE PRODUCTS.

BY PROF. EMILE KOPP, OF ZURICH.

Extraction of Tin from Tinned Iron Waste.

Translated by Samuel Cabot, Jr.

1st Method. *Treatment with Caustic Soda.*—The tin scraps if not already clean should be cleaned by treatment with warm water, in a slowly revolving cylinder; if necessary, a little soda, or very cheap soap may be added to the water.

The scraps are then turned into an iron kettle, covered with excess of caustic soda solution, heated to boiling, and then little by little fine powdered litharge is added.

The oxide of lead dissolves immediately in the soda, but coming in contact with the tin upon the tin scrap is instantly reduced to metallic lead, while the tin is oxidized to stannic acid (binoxide of tin, SnO_2), which dissolves in the caustic soda to stannate of soda.

$$Sn + 2NaHO + 2PbO = SnO_3Na_2 + 2Pb + H_2O.$$

If, after continued boiling, there still remains some lead in solution, the tin is entirely dissolved off the scrap.

The insoluble residue is a mixture of precipitated metallic lead and iron plate. This is washed with boiling water two or three times to free it from all stannate of soda.

The residue consists of spongy precipitated lead and iron plate. The whole mass is placed in a perforated horizontal cylinder which is made to revolve in a tank filled with water. The lead separates and falls through the large perforations in the cylinder, is collected and heated in a shallow iron pan until it ignites and burns to oxide (PbO), which can be immediately used upon a new portion of tin waste.

The clean iron plate which remains behind can be worked up directly into sulphate of iron (copperas) by dissolving in sulphuric acid, and crystallizing. (This might do very well abroad, but it would probably be more advantageous in America to sell it to the iron-workers.—S. C.)

The alkaline solution containing still some oxide of lead is used upon a fresh portion of tin scrap, and freed from lead (which is precipitated as metallic lead) while the partially stripped iron scrap is treated with fresh soda solution.

The whole operation must be so arranged that fresh soda solution is always used upon partially stripped tin scrap, and that this partially saturated stannate of soda always acts upon fresh tin scrap, the stannate of soda solution thus formed is either evaporated to dryness or only to the crystallizing point, and the dried product is sold to calico printers and dyers, for the preparation of cloth for receiving various colors.

A single pound of oxide of lead can in this manner convert many pounds of tin into stannate of soda.

2d Method. *Treatment with commercial muriatic acid.*—Muriatic acid when heated dissolves both tin and iron, but more of the former than the latter. Protochloride of tin and protochloride of iron are formed.

$$Fe + Sn + 4HCl = Cl_2Fe + Cl_2Sn + H_4.$$

After the still acid solution has been allowed to settle and is clear, the tin is precipitated with zinc (waste sheet zinc, etc.).

This precipitation is effected in warm solution, and is best done by first adding an insufficient quantity of zinc, and allowing it entirely to dissolve, then precipitating the remainder upon sheet zinc from which it can easily be brushed.

The spongy precipitated tin is then treated with a little dilute sulphuric acid if there are still any pieces of zinc remaining. It is then washed, dried, and pressed into a crucible with some kind of flux, and melted into pigs. This method can also be slightly varied. For instance, a little nitric acid may be added to the muriatic acid, which gives aqua regia, which acts much more readily upon tin than on iron. In this manner one can obtain, with increased cost, a purer solution of tin.

The solution of protochlorides of tin and protochlorides of iron can also be precipitated with powdered chalk, which throws the tin down as protoxide, but leaves the iron in solution. In this case, however, there must be no persalts of iron present, as the peroxide of iron is precipitated in such a case.

$$(SnCl_2 + CO_3Ca = SnO + Cl_2Ca + CO_2).$$

The protoxide of tin thus obtained can be directly converted into stannate of soda by heating it in an iron pan with carbonate or hydrate of soda with the addition of some nitrate of soda (Chili-saltpetre). This conversion requires a red heat.

The tin waste can also be treated with gaseous hydrochloric acid in a heated stoneware cylinder, and the protochloride of tin in this case is rather less contaminated with iron salts. The solution is treated exactly as above.

3d Method. *Treatment with dry chlorine gas.*—When a mixture of iron and tin are subjected to dry chlorine gas the iron remains untouched while the tin is readily changed to the so-called bichloride (properly $SnCl_4$) which is very volatile, and may be distilled off into a condenser as anhydrous $SnCl_4$, or may be caught in water, and thus obtained as a concentrated solution. The operation is performed in a stoneware or cast-iron cylinder, best placed vertically, into which the chlorine enters from above, and the $SnCl_4$ flows out from below.

The cylinder should be kept cold if necessary by artificial cooling (by cold water), as otherwise the iron may catch fire in the chlorine gas and burn to Fe_2Cl_6, which is a rather volatile substance; besides which the apparatus would receive much injury.

The perchloride of tin has many applications for mordanting, etc., and for the preparation of steam colors. (It also has been used for the preparation of aniline red (fuchsin) in place of arsenic acid, and gives a very fine red, entirely free from poisonous properties. S. C., Jr.—See Am. Chem., iii. 85.)

THE QUANTITATIVE DETERMINATION OF CYANIDE OF POTASSIUM IN SILVER BATHS.

BY DR. G. C. WITTSTEIN.

Translated by Charles M. Rolker.

I was asked to determine the amount of cyanide of potassium in a silver bath, which had served already in electro-plating, so as to ascertain exactly how much silver it would still take up.

As this question has never been discussed in public, to my knowledge, and inasmuch as the solution of this question is not so simple and easy as it may appear in the first moment, I deem it well worth while to lay down my experiences. The method, by which I succeeded, satisfies the technical purposes, although not always the strict analytical requirements. The method consists in transforming cyanide of potassium into acetate of potassa, and extracting the same by absolute alcohol from the well-dried mass;* to change it into chloride of potassium by addition of hydrochloric acid, and to calculate then the amount of cyanide of potassium.

Before I come to talk of the routine of such analysis, let me call your attention to some preliminary points of importance, which are essential in avoiding mistakes.

A. For the repeated use of such solution in electroplating, it is of interest, to ascertain the amount of free cyanide of potassium alone, because from this we can estimate the quantity of silver necessary; but not the amount of cyanide of potassium left, already combined as cyanide of silver and potassium. But as this is finally also determined as chloride of potassium, according to the above method, a special determination is necessary. This determination is facilitated, whenever the amount of silver is known; because with the aid of the formula $KCy + AgCy$, the amount of cyanide of potassium is easily calculated, and from this the required chloride of potassium.

B. A second correction is due to the constant presence of carbonate of potassa in silver baths. It is determined by chloride of calcium, chloride of potassium, and carbonate of lime being formed, and from the weight of this the carbonate of potassa and chloride of potassium are calculated.

C. After subtracting the amount of chloride of potassium calculated from the cyanide of silver and potassium, plus the amount calculated from the carbonate of potassa, from the original amount found, a third correction remains to be made.

The salt exclusively used in electro-plating is the fused cyanide of potassium, produced by heating equal parts of ferrocyanide of potassium with carbonate of potassa. This, as is known, contains, besides cyanide of potassium, large quantities of cyanate of potassa, which quantities are, according to my previous determinations, in the ratio of 7 equivalents of cyanide of potassium to 3 equivalents of cyanate of potassa (My Präparatenkunde, 4th edition, page 446). The cyanate of potassa is also naturally converted into acetate of potassa, and by the action of hydrochloric acid into chloride of potassium. In determining the free cyanide of potassium, allowance has to be made for this amount of chloride of potassium.

To resume, the methods yield choride of potassium from 4 different sources.

1. From the free cyanide of potassium.
2. From the cyanide of potassium of the double salt $KCy + AgCy$.
3. From the carbonate of potassa.
4. From the cyanate of potassa.

The data obtained from 2, 3, and 4, have to be subtracted from the chloride of potassium of 1, and from the difference obtained, the weight of the free cyanide of potassium is calculated.

* Mixture of acetate of potassa, cyanide of silver, and the following salts, never absent in silver-bath: chloride of potassium, nitrate and sulphate of potassa, traces of cyanide of copper, and cyanide of iron.

As explanation, I submit the following practical examples:—

1.

Total determination of potassium in the free cyanide of potassium:—

I mixed 20 cub. cent. of the silver bath in a porcelain dish, with 10 cub. cent. of acetic acid of 20%. Evaporated it to dryness under low flame, and transferred the red residue to a flask. Added absolute alcohol, fitted tight stopper, kept in moderate temperature for 24 hours, and agitated frequently. Filtered and washed residue with absolute alcohol, evaporated nearly to dryness, added 5 cub. cent. hydrochloric acid of 1·120 sp. gr. evaporated to dryness, and weighed. The resulting chloride of potassium weighed 1·125 grains.

2.

Determination of the potassium in the double salt:—

I took 20 cub. cent. of the silver bath, precipitated with sulphide of ammonium, and let it settle under exclusion of air. I collected the black precipitate on a weighed filter, washed it, dried it at 100°, and weighed 0·470 grm. sulphide of silver (AgS), in which there was 0·409 grm. silver. These correspond to 0.508 cyanide of silver, 0·247 cyanide of potassium, and 0·283 chloride of potassium.*

3.

Determination of potassium in carbonate of potassa:—

I precipitated 20 cub. cent. of the silver bath with chloride of calcium, collected the crystalline precipitate,† dried, and weighed it, as 0·094 grm. carbonate of lime. These correspond to 0·129 carbonate of potassa, and 0·140 chloride of potassium.

4.

Determination of potassium in cyanate of potassa:—

After subtracting the 1·283 grms. of No. 2, and the 1·140 grms. of No. 3, from the total amount of chloride of potassium found in No. 1, *i. e.* 1·125 grms., there will remain still 0·702 grm. chloride of potassium, representing the free cyanide of potassium, and the cyanate of potassa. These two salts occur in the fused cyanide of potassium, in the proportion given by the formula $7KCy + 3(KO + CyO)$; whence 0·491 grm. of these 0·702 grm. chloride of potassium fall to the free cyanide of potassium, and 0·211 to the cyanate of potassa (0·229 grm.).

But as 0·491 chloride of potassium correspond to 0·428 cyanide of potassium, 20 cub. cent. of the silver bath do not contain more than these 0·428 grm. of free cyanide of potassium, capable to combine with more silver.

The examined silver bath contained consequently per litre—

21·400 grms. free cyanide of potassium.

12·350 grms. cyanide of potassium, combined with cyanide of silver.

25·400 grms. cyanide of silver (= 20·450 silver).

11·450 grms. cyanate of potassa.

6·450 grms. carbonate of potassa.

This method has the following defects:—

a. The silver does not remain perfectly insoluble; traces of it go to the chloride of potassium, as is indicated by the brownish color ensuing upon addition of sulphide of ammonium, and by its taste.

b. Chloride of potassium is sparingly soluble in absolute alcohol, whence traces of it are extracted when treated with this reagent.—*Polytechnische Journal.*

* To regain the silver of such baths, it is best to follow the same way (copper and iron remain in solution), only to use the cheaper liver of sulphur instead of sulphide of ammonium. Take equal parts of silver and liver of sulphur. If the sulphide of silver is intended for rinsing in electro-plating, or for cases where traces of sulphide of silver are of little or no account, dissolve it in nitric acid, filter off the sulphur, and evaporate to dryness. In case one wishes to produce pure silver or pure nitrate of silver, one must remove the sulphur previously in an open crucible by application of strong heat.

† The precipitated carbonate of lime has a tendency to adhere in small crystals to the sides of the vessel; this did not take place in my experiments, causing no trouble in transferring the precipitate to filter.

DETERMINATION OF SUGAR IN BEETS.

BY DR. A. HEINTZ.

Translated by J. M. Merrick, B.Sc.

The determination of sugar in beets is either direct, when we seek to obtain from a weighed quantity of beets all the sugar, or indirect, when the content in sugar of the expressed juice is determined, and also the amount of juice in the grated beets.

In the latter case we determine by thorough washing in water the insoluble marc in a weighed quantity of beet-pulp and make the juice = beets — marc. Or, we determine, as Müller. Grouven, and Stammer have proposed, by the loss on drying, what per cent. of water the juice [S] contains, and the unpressed beet [s], and all $\frac{s}{S} \times 100$ = the percentage of juice.

Both indirect methods rest upon the natural definition, viz., juice is the total amount of water contained in the beet roots plus all the matters dissolved therein, or capable of solution. The statements of E. Schulze show that by sufficient care both methods may lead to agreeing results. Both processes justify this statement.

But the hypothesis is immediately established that this total juice in its percentage composition, and especially in its contents in sugar, agrees exactly with the tests of the juice which is pressed out and polarized. Margraff, Bley, Pelouze, and Peligot have attempted to determine the sugar in beets *directly;* and among other things they analyzed the extract of previously dried beets. The exact polarization methods of the present time, however, were not at the command of the older experimenters. Hence it has become the custom to reckon the product according to the indirect method, or that based upon the contents of the juice. Latterly, Ferd. Jicinsky, in his comprehensive works, has maintained the direct polarimetric sugar determination. He calls p. the polarization of the beet, P. that of the juice, and $\frac{p}{P} \times 100$ the juice contents of the beet. The point of difficulty with him consists rightly in the amount of sugar; yet the juice is that part of the beet which contains on an average just so much sugar as the expressed juice. Analytical results correspond to the demands of this definition, and to this definition, and no other, must correspond the value of the juice-factor which is employed in reckoning the sugar contents of the beet from that of the expressed juice. The experiments made heretofore have shown that $\frac{p}{P} \times 100$ is always smaller than $\frac{s}{S} \times 100$. Consequently the total water contained in the beet, plus all the matters dissolved therein, contains on an average a smaller amount of sugar than the expressed juice, and the sugar percentage of the beet reckoned in the indirect way is too high. Although these results agree with the

consequences which endosmotic and physical laws demand in the sugar beet, yet they absolutely oppose and contradict a fallacy in which we do not regard those laws which organisms like the sugar beet have undeniably to obey.

In regard to the physiological explanation, it is certain, according to Sachs, that the beet root is not permeated by an everywhere homogeneous juice. Not only do the holes of the cells contain as a saturating fluid a less sweet juice, but the albuminous cells of the vessels contain less sugar than the parenchyma. Hence it comes that we have every reason to believe that the juice permeating the protoplasm of the parenchyma cells contains less sugar than the real so-called cell-juice which fills the spaces of the cells in the mass.

In 1840, Liebig proved that a dry animal membrane takes up in a given time less salt-solution than water. Ludwig plunged pieces of dry bladder into solutions of salt, and Glauber's salt, and allowed them to soak. The solution taken up by them was less concentrated than that offered to them. Then he squeezed the soaked bladders. The expressed fluid was more concentrated, *i. e.*, richer in salts and poorer in water than the average of the solution in which the bladders were put.

Hence it follows, 1st, that the attraction of the membrane examined by Ludwig for pure water was greater than for the salt dissolved therein; and 2d, that in consequence of this attraction the concentration of a solution in a molecular canal of a membrane increases with its distance from the walls of this canal. Since the imbibed fluid in the central part of such a canal is in general less strongly attracted, and therefore more easily expressed, the expressed solution possesses a higher concentration than that held back in the membrane.

Schonbein found, in 1861, that, with few exceptions, water in capillary tubes precedes [outruns] the matters dissolved in it. In the same year Willibald Schmidt made interesting experiments upon the filtration of various solutions under pressure through skin and pericardium, and here too, in general, the water preceded the dissolved matters in the molecular pores, so that with gum arabic under certain circumstances the filtrate showed only one-thirteenth contents of the solution supplied. But with some solutions of decided crystalloids the concentration before and after filtration remained the same. Jamin, Jolly, Brücke, Graham, Hofmeister, Hoppe-Seyler, Traube of Breslau, and Barenetzky, are among those who have undertaken similar investigations.

Noteworthy here is the research made by Sachs* upon the pith of senecio umbrosus. Isolated portions of the pith in sealed glass tubes lengthened several per cent. The interior pith cells appear to withdraw the exterior water and to create a powerful tension of the fibres.

To all these experiments one objection may be made, viz., this may be true with regard to all these various membranes, but it does not force upon us the conviction that a difference in sugar contents exists in beet roots corresponding to that between the cell-membranes and the juices of the cells. This objection I meet with the following experiments. Suppose that an artificial pulp is prepared of air-dried beet-marc, and a pure sugar solution of known strength. Suppose now that the contained water and sugar are proportionally divided, the juice, drained or expressed with all necessary precautions, must have the same sugar percentage as before. But if, on the contrary, the above indicated proposition hold true, viz., that of the capacity of the cell-walls of the marc to absorb water; then more water than sugar will be withdrawn from the juice, and in consequence the expressed juice must be richer in sugar. Fine ground beet pulp was repeatedly boiled with water and pressed and finally drained and dried. It was found to then contain 12·5 per cent hygroscopic moisture. In a flask with a ground stopper was put this marc with a half normal solution of 130·24 grammes of sugar, of 99·6 per cent. sugar [·3 p. c. H_2O ·1 p. c. nichtzucker], in such proportion that there was 1 gramme marc to 20 c. c. of the solution. The closed flask was left to itself for 16 hours with occasional shaking, the juice drained off, filtered, and polarized with the least possible exposure to air. It gave 53·9 degrees against a former figure of 49·8. A portion of similar beet-marc of 11·4 per cent. moisture, with normal sugar-solution in the proportion of 1 gramme to 20 c. c., mixed and treated without delay as above, gave 104·6 degrees, instead of a previous 99·8.

Next I washed in the way described pure beet-marc with alcohol and ether, dried it upon the water-bath, and employed this marc with 11 per cent. moisture, but now in the proportion of one gramme of marc to 40 c. c. juice. In an experiment with half normal solution and 16 hours' action, the juice that drained off spontaneously (about $\frac{1}{4}$ of the whole) and then the expressed juice were examined; the former giving 50·4, and the latter 51, against 49·8 before. An experiment with 40 c. c. normal solution and one gramme of marc gave, after 4 hours, for the juice running off spontaneously, a polarization of 100·7 degrees; for the expressed juice, a polarization of 101·6 degrees, against 99·8 degrees of the previous observation.

The observed smaller concentration of the juice running off of itself may be explained by ordinary capillarity, but I do not assert that it has nothing to do with the swelling of the membrane and with imbibition. I mixed 2·1 grammes of marc of 7 per cent. moisture with 56·7 grammes of half-normal solution, and kept the mixture eight days in a well-closed flask, in a dark, cool place, and side by side with it a sample of the liquor employed, so that the two stood equally long.

According to polarization the original juice had 12·35 per cent. sugar; that expressed from the marc 12·65 per cent. sugar. According to the indirect method we have from $\frac{s}{S} \times 100 = 97·05 = 7·22$, grammes of sugar reckoned upon 12·28 per cent. of the total amount. Really only 7·002 grammes were present.

If I had experimented in a different way and not known directly the amount of sugar present an inexplicable loss of 3·03 per cent. of the nominally theoretical, but falsely reckoned, amount would have been necessarily noted. It will be seen to what errors we come if we take no note of imbibition. We cannot assume that in the case described we have to do with a right polarizing body allied to sugar, for how could such a body after it had withstood a twelve hours' washing and boiling with 100 times its bulk of water, be dissolved in a few minutes by so small an amount of sugar solution? Inverted sugar, or bodies acting like it upon Fehling's solution, were not to be suspected, inasmuch as the last described experiment of the eight days' standing gave from the weakly opaline liquor a precipitate with Fehling's solution that corresponded to only one or two hundredths of a per cent. of inverted sugar.

These positive experiments are modelled, so far as is possible and necessary, upon the relations occurring

* Lehrbuch der Botanik, 3 Aufl. 1873, s. 713.

in nature. No man has yet fabricated a living cell. Micro-chemical quantitative analysis cannot be treated with confidence in such subtle questions.

The phenomena described must be taken into account in criticizing the so-called inexplicable loss in practical working.—*Fresenius's Zeitschrift*, 1874.

DETERMINATION OF THE RELATION WHICH THE TRUE ASHES OF SUGAR, IN INDUSTRIAL PRODUCTS, BEAR TO THE SULPHATED ASHES.

BY CM. VIOLETTE.

Translated by J. M. Merrick, B.Sc.

In the usual method of commercial analysis employed for fixing the value of sugars, it is admitted $\frac{9}{10}$ of the weight of the "sulphate ash" represents very nearly the weight of the real ash, that is to say, the ash we should obtain by direct incineration of the sample without the addition of acid. In a memoir on crude sugars,* I have shown that the coefficient $\frac{9}{10}$ is too high. In the paper which I present to-day to the Academy, I have determined the value of this coefficient for all the products of the sugar industry.

Nature of the Product.	Ash to 100 of product		Ratio of the weight of the two ashes.
	True.	Sulphated.	
I. Crude Sugars.			
1st lot	0·180	0·260	0·692
2d " very white	0·780	0·984	0·792
2d "	1·620	1·924	0·842
3d " mean from twelve refineries	3·113	3·780	0·823
3d " abnormal	8·990	10·330	0·870
II. Molasses [density = 1·384].			
No. 1. Degrove	10·023	13·260	0·755
" 2. Lalouette	11·025	13·960	0·790
" 3. Baroche	10·315	12·720	0·811
" 4. Steam	10·762	13·400	0·803
" 5. Fievet	10·860	13·730	0·798
" 6. " "osmosed"	10·716	13·750	0·780
" 7. Gouvion-osmosed	9·632	12·460	0·772
" 8 = 7. "osmosed"	7·758	9 570	0·810
" 9. Waters of the exosmose of No. 7	20·138	24·830	0·811
III. Beet.			
No. 1. Coppelle [north]			
Upper portion	0·900	1·060	0·850
Middle "	0·920	1·130	0·814
Lower "	0·930	1·070	0·870
No. 2. Coppelle [north]			
"Tetie"	1·02	1·36	0·750
Upper portion	0·78	0·99	0·791
Middle "	0·76	0·93	0·822
Lower "	0·796	0 98	0·810
No. 3. Chauny [Oise].			
Upper portion	0·736	0·897	0·823
Middle "	0·653	0·815	0·803
Lower "	0·681	0·838	0·815
Mean of the beet	0·795	0·967	0·821

From all my experiments I deduce the following conclusions, viz.:—

1. The coefficient $\frac{9}{10}$, adopted by the sugar industry, is too high.

2. We can substitute with much more exactness the coefficient $\frac{8}{10}$—applicable to crude sugars, except the No. 1—to molasses from all sources, to the exosmose waters, and to the beet itself.

3. For very pure sugars the coefficient should not exceed $\frac{7}{10}$.—*Les Comptes Rendus*, lxxix. No. 15.

* Annales de Chimie et de Physique, xxiv. p. 514.

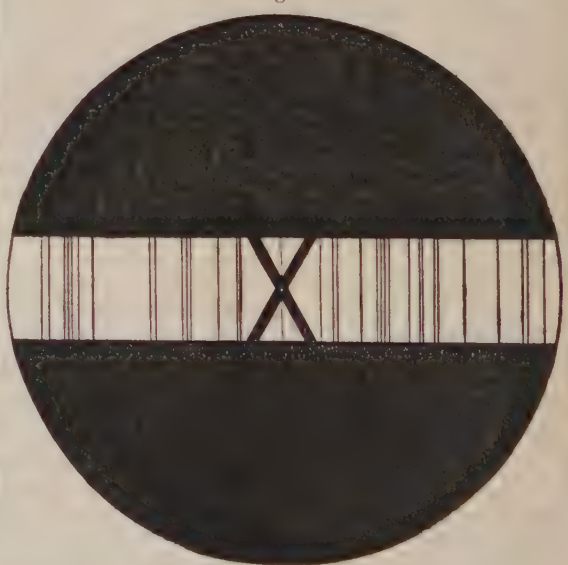
ON A NEW METHOD OF DETERMINING THE POSITION OF ABSORPTION BANDS IN THE SPECTRA OF COLORED ORGANIC FLUIDS.

BY J. C. DALTON, M.D.

The mode adopted, in many of the spectroscopes in common use, for fixing the location of a spectrum line, is by means of two crossed wires, placed in the eye-piece of the instrument, which may be made to traverse, from right to left or *vice versa*, by the lateral movement of the observing telescope, so as to cover in succession every part of the spectrum. The movement of the telescope carries with it a vernier, sliding upon a horizontal graduated circle, upon which the exact position of the telescope tube, and consequently of that part of the spectrum covered by the cross-wires, may be read off at will. The situation of the principal sun lines, A, B, C, D, etc., having been fixed by observation of the solar beam and duly recorded, appearances in any part of the spectrum may afterward be referred to them as fixed points.

This method is well adapted for astronomical or chemical purposes, in determining with precision the location of the dark sun lines or of the bright lines produced by incandescent vapors; since these lines are of excessive fineness and definition, and any one of them may be brought to correspond accurately, both above and below, with the reëntering angles of the crossed wires (Fig. 1). But it is not convenient for the observation of absorption bands. These bands are very different in character from the delicate, but sharp and mathematically delineated sun lines. An absorption band is simply a dim space in the spectrum, the central parts of which may be completely black, owing to the total absorption of light, while the edges are almost invariably more or less shaded off, merging gradually into the adjacent illuminated regions. Thus there is no exact point at which we can say with absolute accuracy that an absorption band either begins or ends; and even the

Fig. 1.



Field of the spectroscope, showing a part of the spectrum, with the sun lines and crossed wires.

position of its centre is necessarily more or less a matter of estimate by the eye. Consequently, the extreme precision of measurement, which is attainable and useful in the case of the sun lines, is neither possible nor necessary for absorption bands; particularly as these bands vary in intensity and extent, and, according to some observers, even a very little in position, with the density of the solutions used for observation.

Beside this, the crossed wires make a coarse and disagreeable object in the field of the spectroscope, and often cover a considerable part of the absorption band which we desire to examine. Owing to this difficulty, a fine vertical silver wire may be substituted for them with considerable advantage. This appears, in the bright parts of the spectrum, as a single dark line, drawn from above downward, and movable, like the crossed wires, with the changing position of the observing telescope. In the dark parts of the spectrum it may be illuminated by means of a lateral opening in the tube of the eye-piece and a small side mirror, so as to appear as a bright line easily visible by contrast.

But the necessary calculation of the position of any object in the spectrum, by reference to the vernier and graduated circle, is still an inconvenience. As all diffused light should be excluded so far as possible from the observing room, a gas-light must be turned on and shut off again each time the vernier is to be examined; and when a series of measurements is to be made in rapid succession, the frequent changes required, from the telescope to the vernier and from the vernier to the telescope, are a real source of annoyance and delay. Add to this the calculation in figures necessary for translating the degrees of the graduated circle into the relative position of the sun lines, and it will be seen that the method in question is in no small degree circuitous and troublesome. For these reasons, I have been led to adopt another plan, in which, by a single direct observation, the position of an absorption band may be immediately and easily referred to that of the adjacent sun lines.

For this purpose, a third or scale telescope is used, similar to that employed in many astronomical and chemical spectroscopes, so arranged as to throw the illuminated image of a graduated scale upon the hither face of the prism, from which the spectrum emerges; so that, when both telescopes are properly focused, the spectrum and the scale will be visible together in the field of the spectroscope.

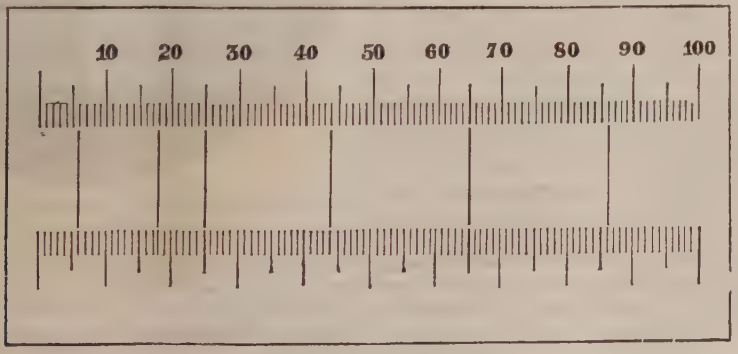
An arbitrary scale is first drawn, with fine black lines in Indian ink, upon smooth, white card-board, about twenty inches long by seven or eight inches wide, with every tenth degree properly numbered, up to 150 or 200, according to the length of the spectrum in the instrument used by the observer; a blank space being left between the corresponding scale line, above and below, which is to be occupied by the spectrum. The first half of such a scale, as drawn upon the card board, is represented in Fig. 2.

Fig. 2.

Arbitrary scale on card-board.

The above scale should then be photographed, in negative, upon a circular glass plate, to be inserted into the end of the scale telescope; the photographed scale to be of such a size that, when seen in the field of the observing telescope, its image will fairly include the entire length of the spectrum.

Fig. 3.



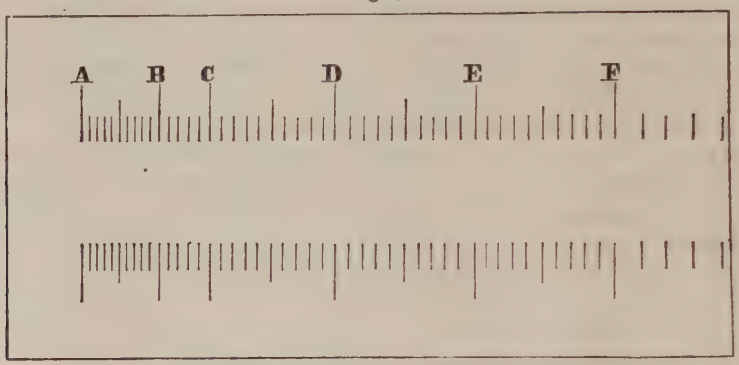
Arbitrary scale, with sun lines.

With the scale thus fixed in position, a sunbeam is then admitted through the slit of the spectroscope, and the position of the principal sun lines, in respect to the degrees of the scale, accurately noted. Suppose, for example, that the line A comes at 6, B at 18, C at 25, D at 44, E at 65, and F at 86, as in Fig. 3; the line G, in the continuation of the scale, coming at 126, and the line H at 162.

These positions of the principal sun lines being recorded, the photographed scale may then be taken out and thrown away. It has done its work, and is no longer needed.

The next thing is to make a new scale upon card-board, of the same size as the old one, but with the sun lines drawn in their proper position, as ascertained by the preceding observation, and plainly marked with the letters belonging to them. The spaces intervening between adjacent sun lines are divided, each into ten degrees, with the exception of the space between B and C. This interval is so much smaller than the others

Fig. 4.



New spectroscope scale, showing position of sun line.

that it is more convenient to divide it into five degrees instead of ten. The first half of the new scale will then appear as in Fig. 4.

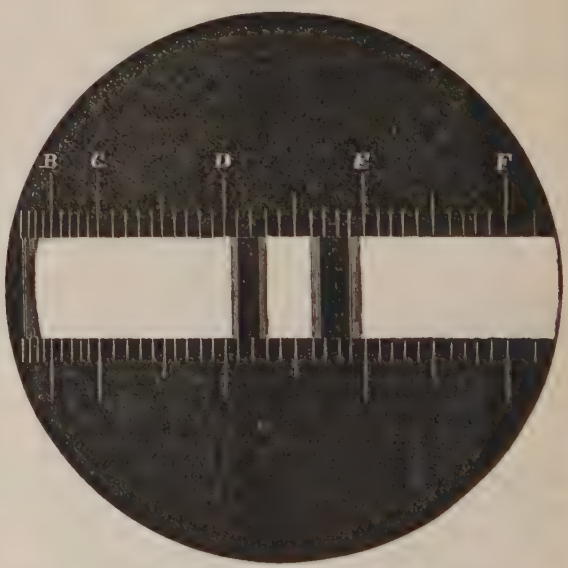
The degrees into which the intervening spaces are thus marked off will vary in size in different parts of the spectrum; the degrees between D and E, for example, being wider than those between A and B, and those between F and G wider than those between D and E. But there is no disadvantage in this inequality, since the degrees, in any case, are only for the purpose of properly dividing the space between any two adjacent sun lines, and of enabling us to measure with accuracy one-half, one-quarter, or one-tenth of the distance from one of these lines to the other.

The second scale, when drawn upon card-board in the manner above described, is then photographed in negative upon a glass plate, to exactly the same size as was done with the first; and this second photographed scale is inserted and permanently fixed in the extremity of the scale telescope. By observation of the sunbeam, the accuracy of position of all the lettered lines is verified: and we then have a graduated scale, visible in the field of the spectroscope, by which the position of an absorption band, in any spectrum, by artificial light, may be determined at a glance, without reference to a graduated circle or any numerical calculation. In Fig. 5 is shown the appearance of that part of the spectrum which contains the two absorption bands of aërated blood, with the corresponding portion of the scale; showing that the first band occupies a little more than the space between the first and the third degree from D to E, the second rather more than that between the sixth and the ninth.

If we express the distance between D and E in hundredths instead of tenths, we should say that the first absorption band of blood extended from 8 to 30 degrees of this distance, and the second band from 60 to 95.

The photographed scale may be illuminated at pleasure by a mirror, from the same burner which furnishes the light for the spectroscope slit.

Fig. 5.



Field of the spectroscope, showing the absorption bands of blood, and the spectroscope scale.

Three precautions are necessary in using the scale arranged as above:—

In the first place, the collimator tube, bearing the slit of the spectroscope, which is usually made movable,

must be permanently fastened with screws, in such a way as never to vary its position with regard to the prism of the instrument; for any such variation will alter the apparent length and position of the spectrum.

Secondly, the scale telescope must also be secured from any accidental change of position. It may be made to traverse, in a horizontal plane, by means of a strong spring and thumb-screw; another thumb-screw being placed underneath for the purpose of fastening it, when the proper position has been reached.

Finally, the distance of the photographed scale from the lens of the telescope in which it is fixed must also be invariable. Changing this distance increases or diminishes the apparent length of the scale, as viewed in the observing telescope; and although this does not perceptibly alter the position of the more central lines, as E and F, it does make a difference with those near the extreme parts of the spectrum, as A, B, G, and H. The most convenient distance for use may be fixed at the time of observing the sun lines with the first arbitrary scale, and it should not be afterwards changed.

The principal practical difficulty in perfecting the arrangement described above, has been that of obtaining a photographed scale on glass, with the lines sufficiently delicate and the intervening spaces sufficiently opaque; so that the dark background of the scale should not admit any light, to obscure or confuse the spectrum. I am much indebted to Mr. Mason, the photographer at Bellevue Hospital, for the ingenuity and perseverance by which, after many trials, he succeeded in accomplishing this result.

It need hardly be said that the two telescopes, bearing respectively the slit and the scale, should be carefully protected from any mechanical shock or pressure which might endanger the accuracy of their position. Everything depends upon this position, once fixed, remaining unaltered; and on that account it is well to repeat occasionally the verification of the scale by observation of the sunbeam, or of the sodium line in a candle-flame, which, of course, should correspond exactly with the D line of the photographed scale.—*Trans. N. Y. Acad. Med.*

CLINICAL UREAMETRY.

BY HENRY G. PIFFARD, M.D.

The procedures most in vogue for the determination of the amount and proportion of urea present in specimens of urine or other fluids may be divided into two classes: 1. Those which can only be accomplished with the aid of extensive apparatus, and great expenditure of time and trouble, and which necessitate for their proper performance the possession of special technical knowledge; and, 2. Those which permit of a tolerably accurate result being attained with means within the reach of every medical practitioner.

To the procedures of the first class belong the methods of Bunsen, Grehant, Millon, and others; while to those of the second belong the processes of Davy, Liebig, Boymond, and one other, to which it is the object of this commuuication to draw attention.

The methods of Davy and Liebig have been before the public for many years, have been described by me elsewhere,* are referred to in almost every manual upon the subject, and hence need not be particularly dwelt upon at present. The method of Boymond, however, is not so well known, and may with propriety be here described, especially as the writer's method was suggested by it. Full details will be found in Boymond's work.*

The theory of this method depends upon decomposition of the urea by nitrous acid, and the determination of the amount of gases evolved during the decomposition and the deduction therefrom of the amount of urea which was necessary to produce the amount of gases observed.

Boymond makes use of a modification of Millon's reagent, which appears to consist of nitrous acid dissolved in a solution of nitrite and nitrate of mercury. He obtains it by dissolving 125 grammes of mercury in 170 grammes of pure concentrated nitric acid, and, when the solution is effected, adds an equal volume of distilled water.

When this reagent is added to a solution of urea, decomposition of the urea occurs, with rapid evolution of nitrogen and carbonic acid. The weight of gas evolved, if unaccompanied with aqueous vapor, is found to stand in the relation of 12 parts of gas by weight to 10 parts of urea. Boymond's formula for this reaction, according to the old notation, is as follows:—

$$C_2H_4N_2O_2 + NO_3 = NH_3 + HO + 2N + 2CO_2.$$

In manipulating this process, Boymond makes use of a decomposition-flask of peculiar construction, which consists of three parts—namely, one to contain the urine, and the others for the reception respectively of the reagent and of strong sulphuric acid. The urine, reagent, and sulphuric acid, being placed in their appropriate receptacles, the whole apparatus is weighed. After weighing, the reagent is permitted to mix with the urine, and the decomposition proceeds until all the urea has been exhausted. The gases, in escaping, pass through the sulphuric acid, and are thoroughly dried. Toward the end the decomposition is a little sluggish, and Boymond assists it by gently warming the flask over a sand-bath. When at last the mixture ceases to evolve gas, the apparatus is cooled and again weighed, the loss in weight bearing to the amount of urea present the proportion of 12 to 10.

Boymond has obtained by this method the following results: in five consecutive experiments, 200 milligrammes of urea, which should have given 240 milligrammes of loss, gave him 245, 235, 238, 242, and 244 milligrammes respectively. This degree of accuracy is greater, we believe, than can be assured by any other known procedure, and the process is one that is certainly to be commended to those willing to take the trouble to perform it carefully. The only objection that can be urged against it is the fact that Boymond's apparatus is fragile, and can with difficulty be obtained in this country; and the effort to perform the necessary manipulations with the ordinary decomposition-flasks obtainable here is attended with much inconvenience.

Having encountered the difficulties referred to, and yet desiring to avail myself of the principles of this process, I was led to certain experiments which resulted in the discovery of a method not quite so accurate, but much simpler and more convenient than the original.

The reagent I employed was obtained by dissolving one cubic centimetre of metallic mercury in 20 c.c. of pure nitric acid, specific gravity 1·400. As soon as the mercury was completely dissolved, 20 c.c. of distilled water were added. This gives a solution which will act upon urea with great energy. The apparatus made use of was one that can be arranged by any glass-blower at a trifling cost, and may be described as follows:—

* De l'Urée, Paris, 1872.

* Guide to Urinary Analysis, Wm. Wood & Co., N. Y., 1873.

A is a small flask, holding about an ounce and a half. *B* is a glass-stoppered test-tube, with a small tube at its lower end passing through a perforated cork, which fits the mouth of the flask. The stoppered tube should hold about three fluidrachms. The cork has still another perforation, in which a small piece of tube, open at both ends, is adjusted.

A remarkably fine specimen of pure urea from Merck was obtained, and a portion was dried for three hours in the water-oven, and then placed over sulphuric acid, and kept for twenty-four hours. This was done to free it from hygroscopic moisture. The flask *A* was then carefully cleaned and dried, and its weight ascertained. A little of the dried urea was then introduced into the flask, and the weight noted. This would insure greater accuracy in the weight of the urea than if a definite quantity of urea had first been weighed and then transferred to the flask. About 10 c.c. of distilled water were added to carry the urea into solution, and a like quantity of the reagent was placed in the stoppered tube. The two pieces of apparatus were now joined, as shown in the cut, and the weight of the whole was taken. The flask was then removed from the balance, and the stopper temporarily removed from the tube, to permit its contents to descend and mix with the urea. The stopper was then replaced, and the flask set aside. The gas resulting from the mutual decomposition of the urea and the nitrous acid escaped through the small tube in the cork, carrying with it, of course, a small quantity of aqueous vapor. This decomposition, according to the modern notation, may be expressed as follows:—

$$2(CH_4N_2O) + N_2O_3 = H_2O + 2H_3N + 2CO_2 + 4N;$$

from which it appears that both the urea and the nitrous acid are decomposed, and, of the products, *water* and *ammonia* remain in the flask, and *carbonic acid* and *nitrogen* escape.

Now, after a number of experiments, it was found that, if the apparatus was again weighed at the expiration of *fifty minutes* after mixing the reagent and the urea, the loss of weight sustained was *very nearly* equal to the weight of urea originally present.

Seven consecutive experiments—six made on one day, and one made the next day—gave the following results:—

1st	experiment,	260	m'g's	of urea	gave	260	m'g's	loss.
2d	"	176	"	"	"	175	"	"
3d	"	129	"	"	"	129	"	"
4th	"	221	"	"	"	231	"	"
5th	"	88	"	"	"	91	"	"
6th	"	89	"	"	"	90	"	"
7th	"	200	"	"	"	199	"	"

The above, reduced to percentages, gives—

1st	experiment.	100·77
2d	"	99·43
3d	"	100
4th	"	104·52
5th	"	103·29
6th	"	101·12
7th	"	99·50
		7)708·63
		101·23

It will be seen that the average error is a fraction over one per cent., and that the extremes of error are about five per cent., a result which is much better than I have ever been able to obtain by either Davy's or Liebig's method. The temperature of the room during the period of these observations was between 60° and 70° Fahr. Subsequently, several analyses of the *same* specimen of urine were made, with the same *uniformity* of result.

I have employed this method during the past eighteen months, for the quantitative determination of urea in urine and other fluids, with perfect satisfaction.

For the analysis of urine, 10 c.c., or, if English measures are employed, two fluidrachms of urine, are carefully transferred to the flask. An equal volume of reagent is then placed in the test-tube, the two pieces of apparatus are joined and weighed. The fluids are then permitted to mix, and at the end of fifty minutes the weight of the flask and contents is again ascertained The loss in weight is about one per cent. greater than the weight of urea in the quantity of urine under examination.—*N. Y. Med. Journal.*

ANIMAL CHARCOAL.

In the old method of manufacturing animal charcoal by calcination, the charcoal only is obtained, and all the secondary products which are disengaged by the action of the heat are lost. These products, however, are rich in nitrogen, and are capable of rendering great service as manure. The trials which have been made to collect them have failed, because their value was less than that of the fuel necessary to obtain them. But this value has increased, and the growing demand made by agriculture for sulphate of ammonia, and for all manures rich in nitrates and phosphates, coupled with the rise in price of these products, have led MM. Dunod and Bougleux, manufacturers at Aubervilliers, near Paris, to substitute the process of the calcination of the bones in pots for one of burning them in vessels from which all the ammoniacal and oily products driven out can be collected. Their method also decreases the losses incurred in manufacture. An interesting report on the subject has lately been presented to the Society for the Encouragement of National Industries by M. Barral.

The bones, on their arrival at the works, are first of all sorted, by which the foreign bodies are removed, and certain classes of bone are set on one side for special purposes. The mass is then thrown into a crushing mill composed of two large cylinders provided with teeth, and between which the bones are crushed as the cylinders revolve. After crushing the bones are placed in boilers with water, and they are submitted to the action of steam to extract the grease from them, which is collected, purified. and sold at about 35*s.* per cwt.

After the grease has been extracted, the bones are thrown into heaps to dry; the temperature of these heaps rises to 140 or 160 degrees Fahr., and the mass gradually ferments, with the result of producing a vast number of maggots. When dry enough the bones are screened, and the pieces passing through the screen are used far making bone powder, which is afterwards reduced to different degrees of fineness by being ground, and then passed through sieves. At the present time from 1100 to 1600 tons of bone powder of all classes are made at the works of MM. Dunod and Bougleux, and it is sold as manure to agriculturists at the rate of about 7*l.* per ton. Analyses show an average of 4 per cent.

of nitrogen, and 40 per cent. of phosphate of lime in this manure.

The carbonization of the bones is conducted in retorts, similar to gas retorts, and when the burning is finished, the contents are drawn into iron vessels, where they are cooled, and the retorts are charged afresh. The gases which escape during the process pass through a condenser composed of ten vertical tubes, which lead upwards to ten others, through which a downward circulation is maintained; the tubes being cooled by water. After condensation the gases are passed through a scrubber, where they are washed, and finally are led back to the retort benches, to calcine the new charge. About 7·5 cubic feet of ammoniacal liquor is obtained from 1 ton of bones, and this is charged with an empyreumatic oil, which is separated by decantation, and forms an article of commerce. The liquor from the condenser measures from 8 to 12 degrees density on Baume's aerometer, and that in the scrubber from 7 to 8 degrees. All this liquor is collected in tanks, mixed, and then pumped into one of Mallet's apparatus for the manufacture of ammonia by the lime process. The ammonia produced is passed into sulphuric acid, and the quantity of sulphate of ammonia obtained varies from 15·5 lb. to 17·5 lb. for each 220 lb. of bones burnt, and about 80 tons of the finished material are produced annually from the works.

The total quantity of charcoal made by MM. Dunod and Bougleux at Aubervilliers amounts to 3000 tons a year. The entire production of the establishment may be divided as follows:—

1. The coarse charcoal, employed for filters and sugar factories.
2. Medium sizes for refineries.
3. The empyreumatic oil.
4. The bone fat.
5. Impalpable black for pigments and blacking.
6. Charcoal for manure.
7. Superphosphate of bones and charcoal for manure, that is, a mixture of bone dust and charcoal, treated with sulphuric acid.
8. Bone powder for agricultural purposes.
9. Sulphate of ammonia, and finally the blanched bones for cupellation, and vitrified bones used in the manufacture of opal glass.—*Engineering.*

CHARCOAL FILTRATION FOR WATER WORKS.

A great variety of substances, both natural and artificial, have been, and still continue to be, used for the filtration of water, as well on a large as on a small scale. These, however, for the most part—especially those used on the large scale—possess the power of mechanical filtration only, and most of them require to be frequently cleansed or renewed. To effect the perfect filtration of water, it is necessary that the filtering media should possess the power of depriving the water of its chemical as well as of its mechanical impurities, and if these two properties are combined in one substance, so very much the better for simplifying the operation of filtration. This double qualification being possessed, in an eminent degree, by animal charcoal, has led to the general adoption of that substance for filtering purposes on the small scale. On a large scale, however, beds of sand and gravel chiefly continue to be used, simply because, until now, no means have been devised by which the valuable properties of charcoal could be rendered available. Even on a small scale its use was, at one time, attended with considerable inconvenience, inasmuch as being used in fragments placed in layers, after a time the particles of charcoal became coated with impurities, and, the pores being clogged, the purifying action ceased. This objection, of course, still holds good in systems in which the charcoal is used in this manner, and although it may be cleansed by washing and baking, it is questionable whether it can ever be perfectly renovated. To meet the objections and to obviate the disadvantages attending the loose charcoal system, Mr. Atkins, several years since, invented and introduced a method of forming the charcoal into porous blocks of any required size, the manufacture being carried on at his works at Chepstow. The process of manufacture is as follows: The purest animal charcoal is first reduced to a fine powder, and is then mixed with Norway tar and other combustible materials in a state of fine powder. The mass is then kneaded into a plastic condition with liquid pitch, and is afterwards moulded into blocks of any required size or shape. The moulded blocks are then exposed to great heat, by which means all the combustible ingredients are burnt out, leaving the pure carbon in a solid form. The block is, as a consequence, perfectly porous throughout, the pores being the cavities from whence the combustible material has been burnt out. Of course there is a limit to the purifying power of these carbon blocks, as well as to the fragments, but the period of service of the former before cleansing is required greatly exceeds that of the latter, whilst all that is necessary is to wash the block in warm water, which will remove the organic impurity. If, however, the carbon is used for filtering water containing much salts of lime, a hard incrustation will form on the surface of the block, which is easily removed by scraping when dry, after which the block is ready for use again.

Hitherto the application of the solid carbon system, although extensive, has been confined to the filtration on a small scale, that is for household purposes, or at most for public buildings or industrial processes. The increasing difficulty of obtaining pure water direct from the water companies, however, has been under Mr. Atkins's consideration for some time past, and he has recently patented a system of filtration by the block carbon system, which is applicable to water works. This arrangement consists of brick tanks of a size proportioned to the amount of filtration to be performed, and divided up into a series of chambers. The water is admitted into the first or settling chamber, whence it flows horizontally through a bed of sand held between two walls composed of perforated or porous materials. After the water has percolated through the sand-bed, which deprives it of its chief mechanical impurities, it has to pass through a series of walls formed of solid carbon plates 12 inches square, and about 2 inches thick, set in an iron framing in a similar manner to panes of glass in a window frame. The frames are placed about 18 inches apart, and the number of these walls, through which the water has to pass, is governed by the amount of purification it is intended the water shall undergo, as well as by the character of the water. Of course the greater the number of walls the higher degree of purity attained, although some waters require much less charcoal filtration than others. After passing through the last wall of charcoal plates, the water is conducted from each tank into a storage reservoir, from whence it is taken for distribution. The filtering capacity of each square foot of carbon plate has been ascertained to be from 300 to 500 gallons per 24 hours; so that, the dis-

tribution being known, the filtering area can readily be adjusted to meet the requirements of the supply. When the action of the plates becomes sluggish, the coating of organic matter can be readily removed by washing in the way we have already indicated; whilst if any incrustation from the salts of lime should occur, the deposit can be easily scraped off when the plates are dry, the tank being of course thrown out of work for the purpose. If a plate become damaged or unfit for use, it can be removed and replaced in a very short time, as, in fact, can each entire frame if necessary. It will be seen that as soon as the surfaces of the solid carbon blocks become encrusted with organic or other matter, or in other words, when the charcoal ceases to fulfil its proper functions, the water ceases to pass through, and thus the inert condition of the filtering media is at once indicated. This is a very important feature, inasmuch as in the loose charcoal system, or in any system of purely mechanical filtration, after the atoms making up the mass have become enveloped in the suspended impurities, the water will continue to flow through the interstices between the particles, and in time may leave the filter in a worse condition than when it entered. This contingency, however, is clearly impossible with the block carbon system, which appears to be well adapted for filtering water on the large scale, to which purpose we anticipate shortly seeing it applied. We are informed that Mr. Atkins has sent in an estimate for applying his system to the works of one large water company, and is in communication with several others upon the subject.—*Engineering.*

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS.

In the preparation of these abstracts the Editors are assisted by the following chemists:—

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S. A. Goldschmidt, E.M.,
E. J. Hallock,
R. Hitchcock,
H. C. Humphrey,
C. A. Joy, Ph.D.,
J. P. Kimball, Ph.D.,
Louis H. Laudy,
J. M. Merrick, B.Sc.,
L. R. Nettre, E.M.,
H. Newton, E.M.,
Prof. F. Prime, Jr.,
Ira Remsen, Ph.D.,
C. A. Schaeffer, Ph.D.,
P. Schweitzer, Ph.D.
W. Shapleigh,
T. O'C. Sloane, E.M.,
Prof. A. P. S. Stuart,
D. K. Tuttle, Ph.D.,
E. Waller, E.M.,
E. H. Williams, A.B.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.

No. 12, 1874.

On the **galvanic conducting power** of fused salts.—Ferdinand Braun.—It was found that no connection is discernible between the conducting powers and other physical properties.

Notice on tertiary **nitrobutan.**—J. Tocherniak.—Tertiary nitrobutan was prepared from the corresponding iodide and $AgNO_2$. As was anticipated, this tertiary product yields neither a bromine-derivative nor a nitrolic acid.

On the action of **nitrous acid on dimethylanilin** and nitrosophenol.—Adolph Baeyer and H. Caro.—When nitrous acid acts upon dimethylanilin, nitroso-dimethylanilin is obtained. When this is treated with caustic soda it is resolved quantitatively into nitrosophenol and dimethylanilin, thus:—

$$C_6H_4(NO)N(CH_3)_2 + H_2O = C_6H_4(NO)OH + N(CH_3)_2H.$$

When oxidized nitrosophenol yields isonitrophenol, when reduced, it yields amidophenol. When nitrosophenol is dissolved in phenol a new body is formed, probably according to the following equation:—

$$N\begin{matrix} C_6H_4(OH) \\ \diagdown \\ \diagup \\ O \end{matrix} + C_6H_5(OH) = N\begin{cases} C_6H_4(OH) \\ C_6H_4(OH) \\ OH. \end{cases}$$

Synthesis of **anthraquinone-derivatives** from benzol-derivatives and phtalic acid.—Adolf Baeyer and H. Caro.—When phenol and phtalic anhydride are heated together with concentrated sulphuric acid, the final product is monoxanthraquinone. The same result is reached when, instead of phenol, anisol, anisic acid, salicylic acid, etc. are employed. The oxyanthraquinone thus obtained consists of two isomeric compounds, one of which is the known variety, the other a new compound to which the name erythroxyanthraquinone is given.—Phtalic acid and pyrocatechin yield alizarin. Phtalic acid and hydroquinone (or substances that yield hydroquinone when treated with sulphuric acid, as quinic acid, potassic thiochronate, etc.), yield quinizarin.

On the relations between chemical activity of the **solar spectrum**, absorption and abnormal dispersion.—Hermann Vogel.—Author has previously shown that by coloring silver plates they might be made sensitive to any colors of the spectrum. It appears that this sensitiveness is not increased by increasing the quantity of the color in the plate, but in many cases actually decreased. The explanation cannot well be given briefly.

Hydrogen peroxide as a cosmetic.—A. V. Schrötter.—The cosmetic known as "Eau fontaine de jouvaine golden," manufactured in London for the purpose of dyeing hair golden yellow, was found to be simply a very dilute solution of hydrogen peroxide containing a little acid.

On derivatives of **benzyltoluol** and **tolylphenylketones.**—H. Plascuda and Th. Zincke.—Benzyltoluol is a mixture of two isomeric varieties; one of these belongs to the para-series, the other apparently to the ortho-series. The derivatives of benzyltoluol prepared some time ago were obtained from the mixture under the supposition that this was a chemical individual. On reinvestigating these derivatives they were found to belong to the para-series, while no derivatives corresponding to the other isomeric benzyltoluol are known.

On α- and β-**benzoylbenzoic acid.**—H. Plascuda.—The properties of these acids and their salts are enumerated.

On **ultramarine.**—E. Büchner.—Author finds that sodium, aluminum, and silicic acid are necessary to the formation of ultramarine. By the action of bisulphide of carbon and sulphur dioxide on natrolite the latter turned blue. From this experiment it is concluded that lapis lazuli (or natural ultramarine) has been formed from natrolite.

Preparation of crystallized **hypophosphorous acid.**—J. Thomsen.—By precipitating the Ba from baric

hypophosphite and evaporating the solution of the acid thus obtained, first in porcelain basins, afterwards in platinum, the acid PO_2H_3 is obtained in form of a white well crystallized mass.

Heat developed in the formation of phosphorous, orthophosphoric, and hypophosphorous acids from their elements.—J. Thomsen.

Heat developed in the formation of arsenic and arsenous acids from their elements.—J. Thomsen.

On **orthocresole** and some other bodies of the *ortho-series*.—Aug. Kekulé.—Carvacrol, when treated with phosphoric anhydride, yields ortho-cresole. The properties of ortho-cresole have been stated incorrectly. It is a solid instead of a liquid. From orthotoluidin may be obtained an iodotoluol which fuses at 205°, and when oxidized with nitric acid, yields orthoiodobenzoic acid. This latter yields salicylic acid when fused with potassa. From this same iodotoluol orthotoluic acid may be obtained by the method of Wurtz.

On **nitrophenol** and **dioxybenzol**.—H. Salkowski.—Nitrophenol of fusing pt. 114°, which is known to be a para-derivative, yields hydroquinone. This result is in harmony with the view already expressed by Petersen, that hydroquinone is itself a para-derivative.

On the identity of Walter's **moringic acid** with oleic acid.—K. Zaleski.—Careful examination proves that Walter's moringic acid is only impure oleic acid.

Concerning the constitution of **phenylbromethyl**.—E. Bandrouski.—When phenylbromethyl is treated with toluol and zinc dust a new hydrocarbon is obtained of the formula $C_6H_5C_2H_4C_6H_4CH_3$. The principal product of the oxidation of this hydrocarbon is parabenzoylbenzoic acid, $C_6H_5COC_6H_4CO(OH)$.

No. 13.

On **maltose**.—Ernest Schulze.—Maltose is a peculiar variety of sugar, obtained by treating starch with an aqueous extract of malt. It has the formula— $C_{12}H_{22}O_{11}+H_2O$. The water of crystallization is given off at 100°. Maltose is converted into grape sugar by boiling with dilute acids

Formation of **aspargic acid** in pancreas-digestion.—S. Radziejeuski and E. Salkouski.—Fresh blood-fibrin was boiled with a pancreas from an ox. As one of the products, aspargic acid was found.

On the **electrolysis of potassium phenyl-acetate**.—T. Slawik.—Monobasic, aromatic acids, particularly phenyl-acetic acid, under the influence of the electrical current, are resolved into an acid and a base; and then, by a secondary reaction, they yield benzoic aldehyde and acid, which are finally oxidized to CO_2 and H_2O.

Oxidation of **orthotoluic acid to phtalic acid**.—W. Weith.—When orthotoluic acid is treated in alkaline solution with potassic permanganate, phtalic acid is obtained.

On the **structure of benzol-derivatives**.—E. Wroblevski.—It is shown that, if we start from any substitution-product of benzol, containing two substituting groups, and introduce a third substituting group, the product is the same, no matter from which series we may start. In addition to instances of this regularity already known, author furnishes a new one, viz , the three varieties of dibrombenzol, when treated with bromine, all give the same tribrombenzol.

On the decomposition of some **diazo-compounds** with water.—E. Wroblevski.—From dibromanilin was obtained dibrombenzol identical in every respect with the dibromanilin described by Meyer and Stüber.

Remarks on the investigation of Hübner and Grete.—E. Wroblewsky.—Author maintains that when sulphuric acts upon metabromtoluol two acids are produced; and also that by the action of nitric acid upon metabromtoluol two substitution products are formed.

Communication.—Röschy and Fassbender.—A body was found in the liver having the properties of an alkaloid, the nature of which was not determined. It is thought that this alkaloid had its origin in the liver.

Simple preparation of the **coloring matter of urine** from that of blood.—F. Hoppe-Seyler.—By the action of reducing agents, as tin and chlorhydric acid, on hæmatin, a new coloring matter is obtained which is identical with urobilin. This urobilin may be easily obtained from the coloring matter of normal urine by a process of reduction; and also from bilirubin by a similar process. It thus appears that the coloring matter of normal feces and the urine is the result of a decomposition of the coloring matter of the blood by reduction, and that the coloring matters of the bile, bilirubin and biliverdin, are intermediate products of this metamorphosis.

Remarks on the communication of M. Traube: Ueber das Verhalten der Alkoholhefe in sanerstoffgasfreien Medien.—Oscar Brefeld.—Author upholds the view already propounded by him that yeast cells cannot develop without the air of oxygen, and claims therefore that Traube's view is incorrect.

On aromatic **phosphorus compounds**.—A. Michaelis and C. Mathias.—Phosphenylic acid and derivatives. When phosphenylic acid is heated rapidly to about 250° it is resolved into metaphosphoric acid and benzol:—

$$C_6H_5PO(OH)_2 = PO_2OH + C_6H_6.$$

Diphosphenylic acid and triphosphenylic acid are formed when phosphenylic acid is heated slowly above its fusing point. Salts and ethers of phosphenylic acid were prepared.

On the constitution of **ethyl sulphite**.—A. Michaelis and G. Wagner.—There are two isomeric compounds possible of the empirical formula of ethyl sulphite, viz.:—

$$C_2H_5SO_2OC_2H_5 \text{ and } SO\begin{matrix}OC_2H_5\\OC_2H_5\end{matrix}.$$

The former is obtained from sodium ethylate and ethylsulphonchloride. The latter is proved to be the ether of sulphurous acid, so that the acid has the constitution

$$SO\begin{matrix}OH\\OH,\end{matrix}$$

and not $HSO_2(OH)$, as has been supposed.

On the constitution of the **crystals of the lead chambers**.—A. Michaelis and O. Schumann.—When PCl_5 is allowed to act upon the crystals the following reaction is realized:—

$$SO_2\begin{matrix}NO_2\\OH\end{matrix} + PCl_5 = SO_2\begin{matrix}Cl\\OH\end{matrix} + NOCl + POCl_3.$$

The decomposition of the crystals by heat takes place in two phases represented together in the following equation:—

$$4SO_2\begin{matrix}NO_2\\OH\end{matrix} = 2SO_2\begin{matrix}OH\\OH\end{matrix} + S_2O_5(NO_2)_2 + N_2O_3.$$

On the compound of **urethans with aldehydes**.—C. Bischoff.—The urethans combine with the aldehydes in such a manner that two molecules of the former plus one molecule of the latter lose one molecule of water. The reaction was carried out with cinnamic, cuminic, and anisic aldehydes with good results. Further with furfurol, acetic aldehyde, and valeric aldehyde.

On improved **apparatus for partial distillation**.—J. A. LeBel and A. Henninger.—Cannot be described without a drawing.

On some derivatives of **phenanthrene.**—E. Ostermayer.—When dibromphenanthrenequinone is oxidized it yields dibromdiphenic acid, $C_{14}H_8Br_2O_4$.

On **Acenaphtylene.** — M. Blumenthal. — A large quantity of this hydrocarbon $C_{10}H_6{<}_{CH}^{CH}{>}$ was prepared and studied. Oxidized it yields naphtalic acid. Treated with sodium amalgam in alcoholic solution it is converted into acenaphtene. Treated with bromine acenaphtylenbromide, $C_{10}H_5{<}_{CHBr_2}^{CHBr}$ is obtained. This latter compound loses BrH when boiled with alcoholic potassa.

Method of preparation and new compound of **stilbene.**—H. Lorenz.—In preparing stilbene by conducting toluol over ignited plumbic oxide, the following products are obtained in addition to stilbene: diphenyl, phenanthrene, anthracene, and liquid hydrocarbons, probably ditolyl. By the action of nitric acid on stilbene dissolved in ether a substance of the formula $C_{14}H_{11}N_3O_2$ was obtained. When this is boiled with alcohol, a compound, $C_{28}H_{22}N_2O_4$, is produced.

On the **coloring matter** obtained from aromatic oxycompounds and nitrous acid.—C. Liebermann.—The substance obtained from phenol has the formula $C_{18}H_{15}NO_3$, and is formed according to the following equation:—

$$3C_6H_6O + NO_2H = C_{18}H_{15}NO_3 + 2H_2O.$$

The corresponding compounds from orcin and thymol are $C_{21}H_{18}N_2O_6$ and $C_{30}H_{36}N_2O_4$.

On **xylindein.**—C. Liebermann.—This is a green substance which is found in dead wood under certain conditions. It was obtained in form of crystals, but the analysis led to no probable formula.

On the action of **hydriodic acid on santonic acid** and on metasantonin. — St. Cannizzaro and Amato.—Hydriodic acid gives with santonic acid an hydrocarbon of the formula $C_{15}H_{26}$ and an iodide $C_{15}H_{26}I$. At the same time there is formed a substance of the same composition as santonin. This is called metasantonin.

On a new method of formation of **phtalic acid.**—W. Weith and R. Bindschedler.—Consists in heating anthraquinone with fuming sulphuric acid:—

$$C_6H_4{<}_{CO}^{CO}{>}C_6H_4 + 2SO_3{<}_{OH}^{OH} = C_6H_4{<}_{COOH}^{COOH} + C_6H_4{<}_{SO_2OH}^{SO_3OH}.$$

On the nitrite and the amide of **hydroxycaprylic acid** and the amide of amidocaprylic acid.—E. Erlenmeyer and O. Sigel.—The amide of hydroxycaprylic acid is obtained by treating the nitrite with fuming chlorhydric acid. The amide of amidocaprylic acid was prepared in a similar manner.

On a true nitrite of **leucic acid,** and the acid obtained from it.—E. Erlenmeyer and O. Sigel.—The nitrite was prepared by combining cyanhydric acid with amylic aldehyde. Fuming chlorhydric acid converts it readily into ammonic chloride and leucic acid.

On **acrolein-bromide.**—Louis Henry.—The bibromide is converted into a polymeric variety by the action of nitric acid, and is not oxidized to bibrompropionic acid.

On some **Japanese alloys.**—S. Kalischer.

On the relative constitution of the **diazo-compounds.** — E. Erlenmeyer. — Author considers diazo-compounds as ammonium compounds of the following general formula:—

$$R—N—R$$
$$\|$$
$$N.$$

The relation between anilin nitrate and diazobenzol nitrate is expressed as follows:—

$$C_6H_5 \qquad C_6H_5$$
$$|\qquad\qquad |$$
$$N—O—NO_2 \qquad N—O—NO_2.$$
$$|| \qquad\qquad ||$$
$$H_3 \qquad\qquad N$$

Investigations on the **volumetric constitution of solid bodies.**—H. Schrœder.—By an examination of the sulphates of magnesium, zinc, copper, and calcium; the sulphates and selenates of magnesium, zinc, copper, cobalt, and iron; several anhydrous potassium double sulphates of the metals of the magnesium series; the anhydrous carbonates of the metals of the magnesium series, etc., the author shows that the principle which he has previously laid down with reference to the volume of these compounds and the volumes of their components hold good.

On **fluoboric acid** and its salts.—A. Basarow.—It is shown that neither the acid nor its salts exist.

Preparation and properties of **triphenylbenzol.**—C. Engler and H. E. Berthold.—The hydrocarbon $C_{24}H_{18} = C_6H_3(C_6H_5)_3$ was obtained as a condensation product of acetophenone by the action of chlorhydric acid. Bromine- and nitro-derivatives were prepared.

On derivatives of **acetophenon-alcohol** and other ketone alcohols.—C. Engler and H. Bethge.—Bromethyl benzol was found to have the constitution $C_6H_5.CHBr.CH_3$. It was obtained by the action of BrH on secondary ethylbenzol-alcohol. Diphenyl-dimethylethan $(C_6H_5)_2C_2H_2(CH_3)_2$, was prepared by the action of sodium on bromethylbenzol and the corresponding chloride. It has the constitution

$$C_6H_5.CH.CH_3$$
$$|$$
$$C_6H_5.CH.CH_3.$$

Monochlorbutylbenzol was obtained by the action of HCl on butylbenzol alcohol. Diphenyl-monochlor-methan $(C_6H_5)_2.CHCl$ may be prepared from benzhydrol by the action of HCl.

On **methylhexylcarbinol.** — Carl Schorlemmer. — Methylhexylcarbinol yields normal caproic acid, and is hence a normal paraffine.

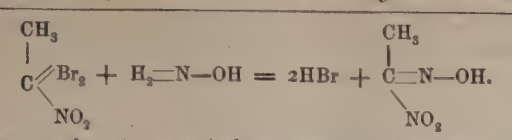
On a new **chloride of uranium.**—H. E. Roscoe.—The new chloride has the formula UCl_5, and is produced when dry chlorine is conducted over a moderately-heated mixture of carbon and any oxide or oxichloride of uranium. It is decomposed by heat into UCl_4 and free chlorine.

On **mesitylene.**—A. Ladenburg.— Dinitromesitylene was prepared by different methods in such manner that in the different products the nitro-groups must replace different hydrogen-atoms. It was found that the three hydrogen-atoms in mesitylene have the same relative value, and from this it is concluded that the symmetri-constitution usually ascribed to the hydrocarbon is correct.

On a new method of formation of **ethylnitrolic acid.**—Victor Meyer and J. Locher.—Acting upon the supposition that ethylnitrolic acid has the constitution

$$CH_3$$
$$|$$
$$C{<}^{N—OH}_{NO_2},$$

the author allowed hydroxylamine to act upon dibromnitroethan, in the hope of realizing the following reaction:—



The experiment was entirely successful, and the original view concerning the constitution of ethylnitrolic acid is thus confirmed.

On the action of **bromallyl on argentic nitrite.**—Robert Schiff.—The products are gaseous, water, and an oil which contains a great deal of bromallyl; and also certain bodies that contain nitrogen, the nature of which was not determined. These results do not agree with those of Brackbusch, who recently obtained allyl nitrite and nitropropylene by means of the same reaction.

On the **synthesis of aromatic acids.**—V. v. Richter.—Dibrombenzoic acid was obtained from nitrodibrombenzol by treating the latter with CNK, and then boiling the nitrite thus resulting with alcoholic potassa.

Analyses of **mineral waters** and salt from Ciechocinek.—F. Wreden and A. Fuchs.

On a compound of **sarcosine** and **guanidine.**—E. Baumann.—Guanidine hydrochlorate and sarcosine combine directly, forming a crystallizing product.

On **sarcosine-uric acid.**—E. Baumann.—When uric acid is added to melted sarcosine the two combine in such a manner that the compound has the composition of one molecule of uric acid plus one molecule of sarcosine minus one molecule of water.

On the **by-products from the preparation of benzyltoluol.**—E. Weber and Th. Zincke.—Among the products identified were anthracene, an hydrocarbon of the formula $C_{21}H_{20}$, and hydrocarbons of very high boiling-point of the general formula C_7H_6. The substance $C_{21}H_{20}$ yields by oxidation two isomeric acids, and is hence itself probably a mixture of two isomeric hydrocarbons. A third acid is also obtained which may possibly be derived from a third isomeric variety of the hydrocarbon. The two acids have the formula $C_{21}H_{14}O_4$, and may be considered as dibenzoylbenzoic acids—

$$\left.\begin{matrix}C_6H_5CO\\C_6H_5CO\end{matrix}\right\}C_6H_3.CO_2H,$$

or as acids of the formula—

$$C_6H_5—CO—C_6H_4—CO—C_6H_4—CO_2H.$$

Further contributions to our knowledge of the **polythionic acids.**—W. Spring.—Blomstrand holds that in hyposulphurous acid one sulphur atom is hexavalent while the other is bivalent. According to this, toluol hyposulphurous acid also contains a hexavalent and a bivalent atom of sulphur. If, however, we consider sulphur as unchangeably bivalent, we are led to a formula for toluol hyposulphurous acid in which the residue H_2S is not in combination with sulphur, but rather with oxygen:—

$$C_7H_7.S—O—O—Cl + KSK = C_7H_7S—O—O—SK + KCl.$$

In connection with benzolsulphuric acid it was found that the reaction analogous to the above takes place in two phases:—

$$C_6H_5,SO_2Cl + K_2S = C_6H_5.SO_2K + KCl + S$$
$$C_6H_5.SO_2K + S = C_6H_5.S_2O_2K.$$

From this it is concluded that in hyposulphurous acid the sulphur is bivalent.

It is further proved that hyposulphurous acid is derived from sulphuric acid by the substitution of one oxygen atom by sulphur. It was prepared by allowing phosphorus sulphide to act upon sulphuric acid. Trithionic acid is considered as a sulphanhydride of hyposulphurous acid—

$$S\left\{\begin{matrix}SO_3H\\H\end{matrix}\right.\qquad S\left\{\begin{matrix}SO_3H\\SO_3H.\end{matrix}\right.$$

Action of phosphoric chloride on **ethylenedisulphuric acid.**—W. Kœnigs.—In successive stages the following compounds are formed.

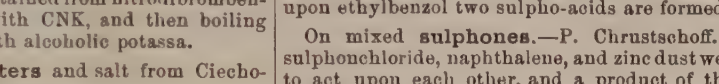
$$C_2H_4\left\{\begin{matrix}SO_3H\\SO_3H,\end{matrix}\right.\quad C_2H_4\left\{\begin{matrix}SO_2Cl\\SO_2Cl,\end{matrix}\right.\quad C_2H_4\left\{\begin{matrix}Cl\\SO_2Cl,\end{matrix}\right.\quad C_2H_4\left\{\begin{matrix}Cl.\\Cl.\end{matrix}\right.$$

On **thiobenzol and thioanilin.**—F. Krafft.—A number of derivatives of thiobenzol were prepared starting in each case from phenylsulphide and thioanilin. It was found that phenylsulphide and thiobenzol prepared from thioanilin are identical.

Concerning **ethylphenol and ethylbenzol-sulphoacids.**—P. Chrustschoff.—When ethylphenol is treated with P_2O_5 ethylene is given off, and in the residue ordinary phenol is found. By the action of sulphuric acid upon ethylbenzol two sulpho-acids are formed.

On **mixed sulphones.**—P. Chrustschoff.—Benzolsulphonchloride, naphthalene, and zinc dust were allowed to act upon each other, and a product of the formula $C_6H_5,SO_2,C_{10}H_7$ was obtained.

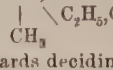
Concerning **mesityl oxide and phorone.**—L. Clarsier.—From the experiments made it is concluded that the formula of phorone is either



Both phorone and mesityl oxide when treated with sulphuric acid are converted into mesitylene.

Two pathological **coloring matters of urine.**—F. Baumstark.—The coloring matters, which in their composition stand in close relation with hæmatine, were discovered in the urine of a patient suffering with leprosy.

Peculiar formation of an **ethylene compound.**—F. Baumstark.—A compound of the formula C_4H_9IO is formed by the action of ethylene iodide on alcohol at 70°. This was found to be

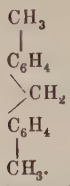


Contributions towards deciding the question concerning position in the **aromatic series.**—Rudolph Fittig and E. Mager.—Nitrobrombenzol was converted into bromanilin and the latter into bromphenol. On heating the bromphenol thus obtained with potassa, resorcine was produced. Now it is known that bromphenol is a para-compound, whereas recent experiments seem to show that resorcine is a meta-compound. An explanation of this anomaly is not given.

Investigations on the **synthesis of aromatic compounds** by the abstraction of water.

I. Compounds of **chloral with brom- and chlorbenzol.**—Othmar Zeidler.—The products first obtained have the composition $CCl_3,CH(C_6H_4Br)_2$, and $CCl_3,CH(C_6H_4Cl)_2$. From these by the action of alcoholic potassa were further produced $CCl_2,C(C_6H_4Br)_2$ and a corresponding chlorine compound. Nitric acid acting upon the first two substances produced $C_{14}Cl_3Br_2(NO_2)_2H_7$ and $C_{14}Cl_5(NO_2)H_7$.

II. On the action of **methylal in toluol benzylchloride and diphenyl.**—Julius Weiler.—Methylal and toluol give dimethylphenylmethan $CH_2(C_6H_4,CH_3)_2$. Bromine and nitro-substitution products were easily prepared. The hydrocarbon has the constitution



By oxidation were obtained dimethylbenzophenon, $C_{15}H_{14}O$, tolnylbenzoic acid, $C_{15}H_{12}O_3$, and benzophenondicarbonic acids, $C_{15}H_{10}O_5$, the groups CH_2,CH_3,CH_3 being successively transformed into CO and CO_2H. When dimethylbenzophenon is treated with sodium-amalgam, it is converted into dimethylbenzhydrol, $C_{15}H_{16}O$. When dimethylphenylmethan is conducted through a red-hot tube, it yields methylanthracene, $C_{15}H_{12}$. When the latter is oxidized, anthraquinonemonocarbonic acid, $C_{15}H_8O_4$, is produced. Chlorine gives with dimenthylphenylmethan a substitution-product. Methylal and diphenyl yield diphenylphenylmethan, $C_{25}H_{20}$. From this were obtained a ketone and a corresponding benzhydrol.

III. **Aldehyde and benzol.**—A. Baeyer.—These two substances yield diphenylethan—

$$CH_3,CHO + C_6H_6 = CH_3,CH(C_6H_5)_2 + H_2O.$$

IV. Action of **chloral and aldehyde on toluol.**—Otto Fischer.—Chloral and toluol give dimethylphenyltrichlorethan. From this by treatment with alcoholic potassa is obtained dimethylphenyldichlorethylene. The first substance yields bromine and nitro-substitution products, and also an oxidation-product. Dimethylphenylethan $CH_3,CH(C_6H_4,CH_3)_2$ is obtained from aldehyde and toluol. By oxidation it yields the same products as dimethylphenylmethan. Under the influence of heat it is converted also into methylanthracene.

V. On a compound of **chloral and thymol.**—Emil Jaeger.—The product is dithymyltrichlorethan $C_{32}H_{37}Cl_3O_2$, the reaction taking place the same as in the case of chloral and benzol.

VI. On the compounds of **phenol with aldehydes.**—Edm. ter Meer.—Anisol and methylal give dimethoxylphenylmethan—

$$CH_2\begin{cases} C_6H_4.O.CH_3 \\ C_6H_4.O.CH_3. \end{cases}$$

Chloral and phenol give dioxyphenyltrichlorethan—

$$CCl_3.CH\begin{cases} C_6H_4.OH \\ C_6H_4.OH. \end{cases}$$

VII. Synthesis of **triphenylmethan and methylphenyldiphenylmethan.**—W. Heinilian.—Trymethylmethan was obtained by the action of P_2O_5 on benzhydrol and benzol thus:—

$$\begin{matrix} C_6H_5 \\ C_6H_5 \end{matrix}\!\!>\!CH(OH) + C_6H_6(H) = \begin{matrix} C_6H_5 \\ C_6H_5 \\ C_6H_5 \end{matrix}\!\!>\!CH + H_2O.$$

By oxidation of this hydrocarbon, triphenylcarbinol, $(C_6H_5)_3COH$, was produced. When P_2O_5 acts upon benzhydrol and toluol, diphenylmethylphenylmethan—

$$\begin{matrix} C_6H_5 \\ C_6H_4.CH_3 \\ C_6H_5 \end{matrix}\!\!>\!CH$$

is the product.

VIII. On **fluoresceine** and the **phtaleine of orcine.**—E. Fischer.—Fluoresceine was obtained by heating a mixture of phtalic anhydride and resorcine. Its constitution is in all probability—

$$C_6H_4\begin{matrix} CO—C_6H_3(OH) \\ CO—C_6H_3(OH) \end{matrix}\!\!>\!O.$$

A corresponding compound is produced by heating a mixture of phtalic anhydride, orcin, and sulphuric acid.

On the occurrence and composition of the **acid of crude petroleum.**—Carl Hell and Emil Medinger.—The substance examined consisted of a mixture of acids. One of these appears to have the composition $C_{11}H_{20}O_2$.

On the action of **nitro-sulphuric acid on ortho-nitrobenzoic acid.**—Peter Griess.—Four products were obtained, viz., styphnic acid and three dinitrobenzoic acids, of which two are new.

On **isocyanphenylchloride.**—Eug. Sell and G. Zierold.—By the action of chlorine upon phenylmustard oil, a product of the formula—

$$C_7H_5NCl_2 = C_6H_5—N=C\begin{matrix} Cl \\ Cl \end{matrix}$$

was obtained. This is isocyanphenylchloride. It is derived from the mustard oil by the substitution of one atom of S by two atoms of Cl. When this chloride is brought together with acetic acid, acetanilin is formed. With Ag_2O it forms phenyl cyanate. With H_2S phenylmustard oil is produced. With anilin it gives a product isomeric with triphenylguanidine, viz.,

$$C_6H_5NC\begin{cases} NHC_6H_5 \\ NHC_6H_5. \end{cases}$$

As a final product of the action of water, diphenylurea was obtained. Alcohol yields the urethran of the phenyl series.

Nitroderivatives of **sulphocarbanilide.**—A. Brückner.—When dinitrosulpho-carbanilide is treated with HCl, it is resolved into nitranilin and nitrophenylmustard oil. By extracting the sulphur from dinitrosulphocarbanilide, dinitro-diphenylguanidin was obtained. By varying the conditions under which the sulphur was extracted, other products were formed.

On the action of **sulphuric acid on substituted anilins.**—George A. Smith.—Sulpho-acids of methylanilin, dimethylanilin, ethylanilin, diethylanilin were prepared and examined.

On the action of **anilin on fulminates.**—A. Steiner.—Anilin and mercuric fulminate give a product $C_7H_5N_2O_2$, or anilin, in which a hydrogen atom is replaced by nitromethyl—

$$\left.\begin{matrix} C_6H_5 \\ CH_2(NO_2) \\ H \end{matrix}\right\} N.$$

Besides there were also found diphenylguanidin and metallic mercury.

On some new **nitrodiphenylamines.**—P. T. Austen. A number of new substances are described which were obtained by processes similar to that employed by Clemm, viz., the action of anilin on trinitrochlorbenzol.

On the conduct of **methylene-iodide** towards some amines.—Julie Zermontoff.—Ethylamine and methylene iodide give a product that was not obtained in a pure condition; on the other hand, trimethylamine and methylene iodide yield the compound $N(C_2H_5)_3(CH_2I)I$. Anilin and the iodide give—

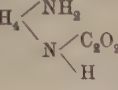
$$\left.\begin{matrix} (C_6H_5)_2 \\ (CH_2) \\ H_2 \end{matrix}\right\} N_2.$$

On some derivatives of **α-phenylenediamine.**—G. A. Barbaglia.—The aceto-compound, the nitro-compound, the azo-compound, and some substances derived from these were prepared.

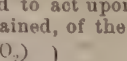
On some derivatives of **toluylenediamine.**—Robert Lussey.—The products obtained were toluyleneurethran and toluylenesulphourea.

On **phenyleneoxamic acid.**—O. Kluseman.—Phenylenediamine was treated with oxalic acid. Two sub-

stances are formed, the oxalate of phenylenediamine and the oxamic acid. The latter has the formula—



On the preparation of **a dinitrobenzanilide**, and its conduct towards reducing agents.—M. MacHugh.—Nitrobenzoylchloride was caused to act upon nitranilin, and dinitrobenzanilide thus obtained, of the formula—



On **nitrocresole**.—Paul Wagner.—Some derivatives of this body were prepared.

Preliminary notice on **selenbenzamide**.—F. V. Dechend.—Prepared by conducting SeH_2 into an ammoniacal solution of benzonitrile in alcohol. The formula is C_7H_7NSe.

On **aromatic sulphines**.—Cæsar Schöller.—When methyl iodide and benzyl sulphide are allowed to act upon each other, two substances are formed, viz., benzyl dimethylsulphine iodide and trimethylsulphine iodide.

On some new organic **selenium-compounds**.—C. Loring Jackson.—When sodium diselenide and benzyl chloride are brought together, dibenzyl diselenide, $(C_7H_7)_2Se_2$, is formed. From this was obtained benzylselenous acid, $C_7H_7SeO.OH$.

On **selencyanthylene** and **selencyanmethylene**.—B. Proskauer.—Potassic selencyanide and ethylene bromide are digested together; the product was—$C_2H_4(CNSe)_2$. By oxidation this is converted into an acid, $C_2H_4\begin{cases}HSeO_3\\HSeO_3\end{cases}$. If methylene iodide is used instead of ethylene bromide, the corresponding methylene compound is obtained.

On **sulphocyanmethylene**. — Julie Lermentoff.—Prepared by treating methylene iodide with potassic sulphocyanide. Disulphometholic acid is obtained from it with difficulty by oxidation with nitric acid.

Action of bromine on **methyl acetate**.—A. Steiner.

Concerning **malonic acid**.—C. Osterland.—The methyl ether and the amide were prepared.

On some derivatives of **secondary butylic alcohol**.—S. Reymann.—The mercaptan, butysulphide and an amine were prepared.

On a **coloring matter analogous to magdola red**.—M. T. Lecco.—Obtained by the action of azodinaphtyldiąmine on paratoluidin hydrochlorate.

On the **ethereal oil of lepidium sativum**.—A. W. Hofmann.—It was found that this oil is identical with that obtained from tropaeolum majus, and is hence the nitrite of α-toluic acid. I. R.

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On the **nitro-compounds of the fatty series**.—Victor Meyer.

On some derivatives of **solid dibrombenzole**.—V. Meyer and C. Wurster.

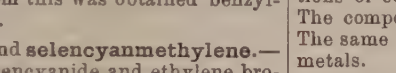
Investigations on the constitution of some **chloral compounds**.—V. Meyer and L. Dulte.

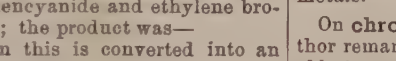
Preparation and investigation of **crystallized xylol**.—Paul Jannasch.—In the preparation of this compound the process of Fittig is modified by treating the bromtoluol with sodium and methyl iodide in benzole solution, by which means the violence of the action is reduced.

Parabromtoluic acid from crystallized bromxylol.—P. Jannasch and H. Dirkmann.

On the conduct of **ozone and water**.—Em. Schoene.—Ozone is partly destroyed by passing through water. The extent of this action depends on the length of time the gas is in contact with the water and the surface exposed. Ozone is dissolved by water in small quantity. The quantity of ozone destroyed by the water is far greater than the quantity absorbed. Ozone does not oxidize water to hydric peroxide. Ozonized oxygen standing over water is converted into ordinary oxygen in about fifteen days, with change of volume.

On the **formation of sulphides** by ammonic or alkaline sulphides.—E. Prirvozuik.—The action of ammonic sulphide on copper is apparently as follows:—





When ammonic sulphide acts upon copper, there are formed, besides the blues, black sulphide, red portions, which appear as groups of crystals under the microscope. This action takes place with the oxidized portions of copper, and copper hammerslag shows it well. The compound is identical with Peltzer's $Cu_2(NH_4)_2S_7$. The same reaction takes place with the oxides of other metals.

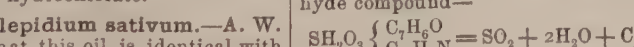
On **chromium superoxide**.—Hugo Schiff.—The author remarks on the experiments of Hintz, who was not able to prepare this compound according to his process published a few years since. Others have found the process successful.

On **benzilic acid and dyphenyl acetic acid**.—R. Symons and Th. Zincke.

Simple arrangement for **filtering at high temperatures**.—Dr. Horvath.—This consists of a flask in which water or other liquid is boiled, the vapor passing off through a tube which is coiled around the funnel, ending in a vessel which receives the condensed liquid.

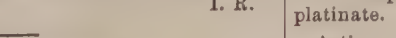
Vol. 171, Nos. 2 and 3.

On **aldehyde derivatives of naphthylamine**.—Dr. G. Paposogli.—Naphthylamine suspended in water through which sulphurous acid gas is passed, dissolves, and upon cooling leaves of a polysulphite are formed. If to the solution in excess of sulphurous acid benzaldehyde is added, a precipitate is formed of an aldehyde compound—



This compound forms no salts, and gives no chloroplatinate.

Action of **amides on phenols**.—Dr. J. Guareschi.—The action was found to take place as follows:—



just reversing the process by which benzamide and phenol are produced from phenyl benzoate.

Historical of **cymole**.—Dr. J. Guareschi.

On **aconic acid**.—Franz Moilly.

On the **Upper Franconia eclogite**.—Dr. V. Gerichten.

Something about a method for the analysis of **crystalline rocks**.—Dr. V. Gerichten.—Process for analysis given in outline.

On a **titanic iron** of abnormal composition.—Dr. V. Gerichten.—This specimen, from the cabinet of the University of Würtzburg, contained only—

Titanic acid	46·42
Ferric oxide	52·67
Ferrous oxide	1·07
	100·16

Formula $(Fe_2O_3)_3(TiO_2)_5$.

The **solubility of tellurium and selenium in sulphuric acid.**—A. Hilger.—Tellurium dissolved in sulphuric acid forms tellurous acid, and sulphurous acid is set free; selenium acts in the same manner.

On the quantitative estimation of **iodine in urea.**—A. Hilger.—The iodine is separated and dissolved in carbon disulphide, and taken up in potassic hydrate, then determined volumetrically with palladium chloride.

Synthesis of **phenylbutylene.**—B. Aronheim.

On an isomeric pyrotartaric acid: **ethyl malonic acid.**—A. Tupoleff.—Formed by substitution from butyric acid with bromine, then potassic cyanide, and finally potassic hydrate. Calcium salt, $C_5H_6CaO_4 + H_2O$. Reheating, there is formed butyric acid and carbonic acid.

On the **ether of monobromo butyric acid.**—A. Tupoleff.—Distils at temperature of 174° (178° Corr).

On some sulphur derivatives of primary **butyl alcohols.**—N. Grabowsky and A. Saytzeff.

On the reduction of **succinyl chloride.**—A Saytzeff.

Conduct of **acrylic acid** towards acid solutions of nascent hydrogen and oxidizing agents.—E. Linnermann.—Acrylic acid is oxidized with difficulty by chromic acid, and yields no acetic acid. Silver oxide has scarcely any effect, and yields no acetic acid. Nitric acid acts readily, but furnishes no acetic.

On the iodine derivative of **orcin.**—John Stenhouse.

On **α-bibrompropionic acid.**—O. Philippi and B. Tollens.—The authors have succeeded in preparing considerable quantities of this acid, and show its isomerism with the β-acid.

On the **β-monobromacrylic acid** from **β-bibromprossionic acid.**—Rich. Wagner and B. Tollens.

Theory of **dissociation** or **"thermolyse."**—Fr. Mohr.—This theory may be stated as follows: Dissociation is the opposite action of chemical combination, whereby the gaseous body again takes up its molecular motion as heat, and takes on a new form of motion, which it has lost by the combination. The quantity of heat which the dissociated bodies take up is the same as they lose by combination. The temperature of decomposition is higher than that of combination. Compounds of which the constituents are not volatile cannot be dissociated. This theory accepts a new kind of motion designated "chemical motion."

On **octylic** and **caprylic acids.**—J. J. Van Renesse.—These acids are shown to be identical. R. H.

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February 20, 1874.

On the **feculometer.**—L. Bondonneau.—Experiments are cited proving that the delicacy of action of this instrument is impaired by the presence of certain impurities, as cellulose, potato pulp, etc. It is suggested that a preliminary test with caustic soda be made. If the solution tested is pure, with this reagent it gives a colorless, translucent substance. If, on the contrary, it is impure, a yellowish color will be visible, and the starch will become thick, in which case a chemical determination will be essential to accuracy.

On **dextrine.**—L. Bondonneau.—Experiments lead to the following conclusions:—

1. Dextrine, at a high temperature, is changed into glucose in the presence of an inert gas charged with moisture.

2. The quantity of glucose formed is greater in proportion as the fecula used is more acid, and the isomeric transformation is equally more prompt.

On the production of **black phosphorus.**—E. Ritter.—Some have found difficulty in its manufacture, and have called in question the researches of the discoverer. The reason for this disagreement is, that more recent experimenters have used pure phosphorus. The result is due rather to a species of liquation than to allotropism, the formation of black phosphorus being due to the presence of some impurity. Arsenic is most frequently the substance that gives this property, although other metals would probably serve the same purpose.

On **oxalurate of ethyl** and **cyanurate of oxamethane.**—E. Grimaux.

Upon combinations of **glucinum.**—Al. Atterberg.—This element is remarkable for the facility with which it gives basic salts, of which the greater part are soluble and very stable. The basic salts of glucinum ought to be regarded as molecular combinations of neutral salts and of glucinic hydrate. All the basic salts which are not altered at 100° contain, dried at that temperature, the same quantity of water as the neutral salts dried at the same temperature, increased by the quantity of water contained in the hydrate dried at 100°. A large number of salts of glucinum are made and discussed.

Researches upon **tribromacetic acid.**—H. Gal.—The synthetic preparation of tribromacetic acid is attained by the reaction of fuming nitric acid upon hydrate of bromal.

On the essence of **alan-gilan** (*anona odoratissima*).—H. Gal.—This natural essence, on being treated with repeated portions of potash, exhibits a peculiar saponification. The saline solution in which this action has taken place, on being treated with hydrochloric acid, gives crystals which present all the chemical properties of benzoic acid. Analysis proves it to be identical with this substance. The part insoluble in potash seems, by its reactions, to be a mixture of oxygenated substances, approaching the alcohols in composition.

Objections to two notes by M. Henrivaux upon the **insolation** and **devitrification of glass.**—M. Bontemps.—M. Gaffield, of Boston, has expressed himself as vexed at the note of M. Henrivaux, conveying the impression that his recent researches upon glass were simply a repetition and confirmation of those of M. Pelouze. M. Bontemps considers the experiments as entirely otherwise, and of great value in establishing new facts, some of which he designated. He further concludes that, contrary to the opinion of M. H., the subject of devitrification is by no means fully settled. The note of M. Wieser is considered of real importance, and there is much more room for profound study on this subject.

Determination of **tannin in gallic acid** and in **pyrogallic acid.**—Maurice Prud'homme.—This determination depends upon the change of color that a solution of tannin undergoes by the addition of chloride of calcium in the presence of some aniline color, as methyl green.

On the **isomerism of terebenthene** and of terebene from a physical point of view.—J. Riban.

March 5.

Upon the combinations of **lanthanum**.—P. T. Cleve.—The pure oxide of lanthanum was obtained by precipitating the mixed nitrates of lanthanum and didymium by ammonia, by which means the greater part of the didymium is separated as basic nitrate, and, by repeated precipitations, a solution containing nothing but lanthanum is obtained. Oxalic acid precipitates this element as oxalate, from which the pure oxide is obtained by ignition.

The atomic weight has been previously given by M. Marignac at 138·7, but a number of determinations have given the author 139. Lanthanum is considered as triatomic, a theory which is supported by an examination of the salts, a large number of which are described.

Yttrium, erbium, cerium, lanthanum, and didymium constitute a special group of triatomic metals, in which cerium and lanthanum form one division, yttrium and erbium another, while didymium holds an intermediate place.

On the **ferment of beer**.—P. Schutzenberger.—If the ferment is dissolved in water, and allowed to stand at 35° to 40° for twenty-four hours, a greater part of its protein insoluble bodies are transformed into soluble products, without any appearance of putrefaction. Thus 100 gr. of the fresh ferment contain 30 gms. of solid matter, giving up to boiling water 8 gms. of soluble principle, and after digestion it yields 18 gms. From this extract the author obtains arabine, tyrosine, and lucine, mixed with a sulphurous substance from which it is impossible to separate it by repeated crystallization. From the determinations made we conclude that the principle extracted from the beer comes in part from the insoluble non-nitrogenous matters therein contained. The phenomenon of alteration is the result of the physiological action of the ferment upon its own elements, an action which takes place, but with less intensity, in the presence of sugar or of oxygen.

On some double **salts of sulphurous acid**, and upon **cobalti-sulphurous acid**.—E. Berglund.

On the preparation of **kermes**. The action of carbonates of the alkalies and of the bases of the alkaline earths upon sulphide of antimony.—A. Teneil.—The results of these determinations may be summed up as follows:—

1. The formation of kermes in the wet way takes place only with carbonate of soda.

2. In the dry way carbonate of potassa produces more kermes than carbonate of soda.

3. Sulphide of antimony is not decomposed by carbonate of potassa in the wet way, and this characteristic may be used as a test for soda in carbonate of potassa.

4. In the wet way the hydrate of lime does not attack sulphide of antimony.

5. The hydrates of baryta and strontia do not attack sulphide of antimony.

March 20.

A new saccharimeter for light fully monochromatic.—Léon Laurent.—The principle which is applied consists in interposing between the polarizer and an ordinary analyzer, a diaphragm, of which one part alone is filled with a thin cleavage plate of gypsum or of quartz cut parallel to the axis; by which means the plane of polarization is changed 180°. Placed at 45° to the plane of polarization, between two Nicols, of which principal sections are perpendicular, it gives the yellow corresponding to the line D of sodium, whether white or yellow light be used. If the analyzer is turned 90° with white light, it gives the complementary color blue; but with pure yellow light it gives black. In order to obtain pure yellow light from sodic chloride, a thin plate of potassic bichromate is placed between the flame and the polarizer, or directly before the eye, thereby absorbing nearly all the rays except the yellow.

On **didymium**.—P. T. Cleve.—A variety of salts are made and described. Making use of a perfectly pure oxide, the atomic weight is found to be 147.

On the **salts of selenious acid**.—L. F. Nilson.

On the **preparation of malonic acid**.—M. Franchimont.—5 parts of acetic acid are heated with 4 parts of bromine in sealed tubes at 204°. Very pure bromacetic acid is given off, which is heated with alcohol in a closed vessel on a water-bath for an hour. The ether thus prepared is precipitated and washed with water, after which it is dissolved in alcohol, with the addition of cyanide of potassium, when the reaction takes place immediately. After heating to boiling and filtering, to the filtrate potassa is added, and the liquid left at boiling till it gives off no more ammonia. Saturate with acetic acid, and precipitate with acetate of lead. The precipitate may be decomposed either by sulphhydric acid or sulphuric acid. Thus a small quantity of malonic acid is obtained, mixed with some bromine compound and with succinic acid, from which it is difficult to separate it.

Process for the **comparative determination of tannic substances**. — Ern. Schmidt.—The problem solved is, knowing that a certain weight of tannin is necessary to produce a known result, how much of a body containing tannin must be used to produce the same result. The methods of former investigators are modified—

1. In the manner of preparation of the solution to be tested, by which a large portion of the resinous, albuminoid, and mucilaginous bodies are eliminated.

2. In preparation of the test liquid, in which neutral acetate of lead is used as the precipitant, and iodide of potassium as the test solution.

3. By the employment of animal black, not for the total but for the partial absorption of the tannin.

The process, though not exact, is considered useful on account of its simplicity.

A new apparatus for the **determination of the tannin** contained in the various astringent matters used in tanneries.—A. Terreil.—The author describes the apparatus used, and the process dependent upon the absorption of oxygen by tannin in the presence of alkaline solutions. Results sufficiently exact for industrial determinations.

April 5.

On the action of **hypobromites upon the nitrogenous matters of urine**.—Application to the determination of urea and uric acid.—E. Magnier.—Solutions both of urea and of creatine are completely decomposed in the cold by hypobromite of sodium. With uric acid, hypobromite sets free only one-half of ths nitrogen in the cold, but all on application of heat. The results of determinations correspond closely with the theoretical values. The apparatus and method of determination is described, and a formula is given by which the weight of uric acid may be found.

Upon a natural **phosphate of cerium containing fluorine**.—F. Radominski.

On the action of **ammonia upon acetone**.—W. Oechsner and A. Pabst.—From a variety of experiments it is concluded:—

1. That in the action of ammonia upon acetone, traces of methylamine and of aldehyde are not formed.

2. That the product of the reaction of these two bodies

one upon the other, known for a long time, is nothing else than the acetonine of Staedeler.

April 20.

Note upon the **chemical purification of wool.**—MM. Duclaux, Lechartier, and Raulin.—Among other facts of value it is proved :—

1. That the preservative baths of salts of tin, alumina, etc. in common use, are without value in the preservation of the fabric, and detrimental to subsequent dyeing.
2. Sulphuric acid is superior to other reagents in this operation.
3. Foreign matters are not carbonized by dilute sulphuric acid, except on heating the solution nearly to 100°.
4. The mean quantity of acid necessary, varies in inverse proportion to the temperature and the time during which the fabric is dried.
5. An apparatus for depriving the fabric of water by centrifugal force is essential.

Researches upon **erbium and yttrium.**—P. T. Clève.—A variety of salts of these elements are described. Although in a previous communication the author in connection with M. Hoegland has considered these elements as diatomic, from these recent researches he considers them as triatomic. Hence their atomic weights are, Y = 89·55, Er = 170·55. E. H. S. B.

Les Comptes Rendus de l'Académie des Sciences.

Volume 79, No. 8.

Ninth note on **guano.**—Chevreul.

On the **effects of powder** in fire-arms.—Sarrace.

On the **passive state of iron.**—Note 2.—A. Renard.—With reference to the action of nitric acid on iron.

The combination of **chromic acid with wool and silk,** and its application to dyeing and the analysis of wine.—E. Jacquemin.—Showing that in the case of wool and silk, but not of cotton, the chromic acid forms a permanent yellow compound with the fibre of the cloth, indestructible by washing. It will also absorb with it into the fibre other substances to modify the color.

Wool died in chromic acid, introduced into natural wine, after prolonged boiling, takes a characteristic brown color, which adulterated wine would fail to give under the same circumstances.

Note in connection with the preceding on **dyeing with picric acid.**—Chevreul.

The **ureides of pyruvic acid** and its bromine derivatives.—E. Grimaux.—Pyruvic acid mixed with its own weight of urea and heated at 100° gives $C_{12}H_{14}N_8O_4$ (A), soluble in 250 parts hot, 1000 cold water, easily precipitated by acids from its alkaline solutions, destroyed by boiling with potash or baric hydrate. Boiled with excess of nitric acid it gives $C_{12}H_{10}N_8O_{22}$. Two parts of urea with one of pyruvic acid give a different product, $C_{10}H_{16}N_8O_7$ (B), with much the same properties as (A), giving the same compound with excess of nitric acid. Finally, a third product is obtained by treating pyruvic acid with half its weight of urea. This product is not appreciably soluble in 1000 times its weight of boiling water; unlike (A) and (B) it does not seem to be affected at all by prolonged boiling with nitric acid. Its formula is $C_{12}H_{10}N_8O_{11}$. With ammonia-nitrate of silver it gives $C_{12}H_4Ag_6N_8O_{11}$.

Equal weights of tribromopyruvic acid and urea heated, undergo an active reaction and give $C_{10}H_8Br_6N_8O_6$. These products seem similar to the series that includes uric acid, xanthine, and sarcine. These researches are to be continued further.

Analysis of pieces of **veal, mutton, and pork** sold in the Paris market, 1873–4.—Note 2.—Ch. Méne.—Not suitable for abstraction.

Note on the **physiological action of apomorphine.**—C. David.—Giving the influence of different agents, chloral, morphine, etc. on the action of the chlorhydrate of apomorphine and its intoxicating effects on various animals.

Action of the **sulphydric acid of the Luchon Springs on granite rock.**—F. Garrigan.—It has been shown in a previous note that these waters contain a sulphydrate of an alkaline sulphide in solution, and that on account of their elevated temperature they are capable of giving off sulphydric acid. This sulphydric acid penetrates the rocks, and where they are porous with free access of air forms sulphuric acid and water, in other cases sulphur is deposited. In the former case sulphates are often found in the rocks.

Results of analysis :—

Silica		3·590
Sulphate of lime	lime . .	27·990 } 67·975
	sulphuric acid	39·985 }
Free sulphuric acid . . .		0.762
Water and loss		27·673
		100·00

No. 9.

Remarks on recent researches concerning the **explosion of powder.**—MM. Roux and Sawan.—Giving the heat and the weight and volume of gases disengaged by different varieties of powder made in France.

No. 10.

Sixth note on the **electrical conductivity of woody substances.**—Th. Du Moncel.—A study of the effects produced on the conductivity of various kinds of wood by drying, coating with paraffin, soaking in varnish, and other insulating liquids, compression, etc. etc.

The nature of the **sulphur compound in the mineral waters of the Pyrenees.**—E. Filhoe.—Maintaining that these waters contain monosulphide of sodium, and not the sulphydrates. That the natural water when treated with an excess of carbonate of lead yields no carbonic acid, differing in this respect from water containing sulphydrate artificially prepared, is a statement which was made some time ago by the writer in proof of this, but has been since found to be not strictly correct. Still it is claimed that it is the monosulphide which is present in these waters. Water, containing in solution a sulphydrate and free carbonic acid, must contain, at the same time, free sulphydric acid, whereas arsenious acid does not show the presence of free sulphydric acid in these waters. Moreover it is a mistake to attempt to determine the free carbonic acid by means of sulphate of lead, for that decomposes carbonates, thus

$$NaHS_2 + 2PbSO_4 + NaCO_3 = 2PbS + 2NaSO_4 + CO_2 + HO.$$

On adding a solution of arsenious acid to a solution of monosulphide of sodium, the mixture remains colorless, but a little dilute sulphuric acid will make the brown color appear. Just enough sulphuric acid is required to convert the monosulphide to sulphydrate. When a sulphydrate solution is treated as above, it only requires the first trace of sulphuric acid to make the coloration appear. Tested in this way the waters mentioned above appear to contain the monosulphide, and not the sulphydrate.

Note on **chlorophyll.**—Giving an account of the action of chlorhydric and sulphuric acids on chlorophyll from various plants, and a description of the very minute crystals that may be obtained, and the proper-

ties of the substance composing them. The brown matter of the chlorophyll, coming from monocotyledonous plants, appears to be crystallizable, while, as far as observed, that from dicotyledonous plants is not.

J. M. M.

Archiv der Pharmacie.

December, 1873.

Examination of **water with reference to health.**—E. Buchardt.—Bad drinking water is supposed to induce disease from its organic matter in various stages of decay. This organic matter in thickly settled places proceeds from decaying vegetable and animal substances containing more or less nitrogen and alkali; and the more unstable its condition is, the more dangerous to health it is thought to be, although how it induces disease is a problem yet to be solved. It is seldom that decaying products like NH_3, H_2S, and CH_4 exist in well water so abundantly as to be readily detected; but when that is the case, the water, according to the writer, may be rejected as unhealthy. Great stress is laid on HNO_3, not so much because it is itself injurious to health as because it indicates the presence of decaying nitrogenous matter. Chlorides and sulphates are usually, though not always, present together in water, and often proceed from decaying matter. Finally, the methods are described which the writer deems best for detecting and estimating Cl, H_2SO_4, HNO_3, CaO, MgO, and organic substances.

Taking **photographs on dry collodion plates.**—Dr. J. Schnauss.—The treatment of dry collodion plates differs entirely from that of moist plates; for while the latter are carefully protected from every substance of an alkaline or reducing nature, the former require these substances for their most successful treatment.

An alkaline, or at least a neutral solution, and silver bromide are the substances used in the most recent dry process. An alkaline solution is thus used. The plate is first moistened with water or alcohol, then with a fresh solution of ammonium (sometimes sodium) carbonate. Then one applies to the plate a solution of pyrogallic acid, which is best prepared by dissolving the acid in a concentrated alkaline solution, and diluting with the proper quantity of water when it is to be used.

The silver bromide suspended in collodion is best prepared, according to Worthley, by adding cadmium bromide to the collodion; then dissolving a somewhat larger quantity of $AgNO_3$ than is necessary for its decomposition in the smallest possible quantity of hot alcohol, and finally by adding the latter drop by drop to the former, and stirring the solution vigorously. The solution thus prepared has a milky appearance, and when used is poured on to the plate, allowed to harden, and then dipped into a water-bath until the surface is moistened, when it is exposed to the light; or, if the plate is to be used dry, the surface is coated with a preserving solution consisting of a solution of gum arabic, sugar, and tannin. This new process, by avoiding the negative silver-bath, has elicited great attention among photographers in both hemispheres.

Analysis of the **Carl spring at Helmstedt.**—Dr. A. Hosaeus.—The result is, that this spring is a chalybeate water containing a medium quantity of iron, with comparatively very small quantities of other ingredients.

Formation of **sugar in animals.**—A. Bernard.—It is said that a solution of cane sugar injected into the veins of an animal will reappear in the urine, while a solution of grape sugar, treated in like manner, will be absorbed by the system, from which it is inferred that the former is not nutritious, and that the latter is. Cane sugar is said to be changed by the digestive organs into grape sugar, and thus an innutritious material becomes nutritious. The same change takes place in plants. Healthy blood contains sugar, while the blood of diseased animals is said to contain none. If sugar be taken into the stomach only a certain amount will be taken up by the system, the rest will be excreted by the kidneys; and if no sugar be taken into the stomach still the blood will contain sugar. In animals the organ which secretes sugar is supposed to be the liver, for the blood before entering the liver is said to be free from sugar, and on leaving the liver to contain it.

Behavior of the **carbohydrates and similar bodies to acetyl acetate.**—Schützenburger.—If one part of cellulose (cleansed cotton or Swedish filter paper) be heated with 6 or 8 parts of anhydrous acetic acid in a sealed tube, it will dissolve in one or two hours to a thick syrup of a dark-brown color. When treated with water a precipitate is formed which redissolves in anhydrous acetic acid. The solution is rendered colorless by filtering through animal charcoal, and when treated with water a precipitate is obtained, which when dried is a white powder. It is cellulose triacetate, and is insoluble in water, alcohol, ether, or benzol. Treatment with alkali regenerates the cellulose. Cellulose may, therefore, be considered a triatomic alcohol. A similar starch triacetated can be obtained, and if not heated above 150°, when decomposed by an alkali, the reproduced starch will give the usual blue color with iodine. Heated above 150°, the starch is converted into dextrine. Two varieties of inuline give, the one a triacetate, and the other a pentacetate. Gum Arabic gives a pentacetate. Glucose yields a di- and a triacetate. Cane sugar and milk sugar yield the same triacetate as glucose. Mannite yields a hexacetate.

How to test **meal and bread.**—J. A. Wanklyn.—The ashes of 100 grammes of meal weigh about ·7 gramme, and if alum has been added the ashes may weigh ·03 gramme more. The ashes are treated with ½ c.c. of oil of vitriol, heated until the acid begins to escape, then diluted with a little water and filtered. Add then 1½ gramme of caustic potash to neutralize the acid and hold the alumina in solution, filter, and add to filtrate 1½ gramme of sal ammoniac, heat a little, and set aside. The alumina, if present, will separate and settle as a phosphate. This is washed, dried, and weighed.

Whether meal be good or bad can be determined thus: Good meal (100 grammes) should yield as an extract, when treated with water, only about 4·69 grammes; bad meal, from 12 to 18 grammes.

Distribution of **iron in the constituents of the blood.**—Boussingault.—Three constituents of the blood of a half fattened cow, fibrine, blood corpuscles, and albumen, were examined, with the following results:—

Fibrine contains . .	·0466 %	of iron.
Blood corpuscles . .	·3500 %	"
Albumen . . .	·0863 %	"

The corpuscles contain, therefore, seven times more iron than fibrine, and four times more than the albumen.

The medical properties of the **South American cowtree.**—J. R. Jackson.—Several species of trees in South America are called cowtrees from the fact that their sap has the appearance of milk. In some cases it is nutritious and is used by the natives as food; but one in particular, that of Clusia galactodendron, is distinguished for its medicinal properties, and is chiefly remarkable for curing dysentery.

Contributions.—Julius Mueller.

1. Rare case of **stearhoe.**—The feces of a patient were examined and found to contain a substance re-

sembling fat. It was proved to be fat by resolving it into glycerine, palmitic, stearic, and oleic acid. Bicarbonate of soda and stimulants were prescribed. After four weeks the feces of the patient were again examined. No fat was found, but, singular to say, soap. The inference is that the medicine excited the digestive organs, perhaps the pancreas in particular, so that the fat was decomposed. The fatty acids, however, not being entirely decomposed and assimilated, were saponified by the alkaline carbonate prescribed, and hence the soap found in the feces.

2. To prepare **liver oil** containing sesquioxide of iron. —One part of benzoate of iron is thoroughly triturated with 100 parts of liver oil and with frequent agitation allowed to stand several days and then filtered.

3. How to prepare Lister's **carbolized gauze bandages.**—Fine muslin or gauze previously washed and dried is cut into pieces of the proper size and then impregnated, as in the preparation of wax paper, with a melted mixture of 200 parts of yellow wax, 50 parts of oil, and 50 parts of carbolic acid.

4. One part of **crystallized aniline** violet dissolved in 30 parts of spirit and added to 30 parts glycerine, forms a very good substance with which to stamp banker's checks, etc. A. P. S. S.

Journal de Pharmacie et de Chimie.

October, 1874.

On **herniarine.**—M. Gobley.—This substance is extracted from the leaves of the *Herniaria glabra*. Its composition was found to be

C . . .	61·23
H . . .	4·46
O . . .	34·31
	100·00

On the influence of **quinine salts on the development of mould.**—G. Fleury.—On sodic bitrartrate it had no effect. On sodic acetate the effect was that of retarding the development of mould. With tannin it preserved the solution from alteration.

Analysis of **thymic acid, thymol.**—M. Lepage.—Place in a test-tube 3 grms. of an alcoholic solution of potassa (1:10) and add ten drops of the acid to be tested, close the tube and shake, then allow it to stand. If the thymic acid is pure, the solutions mix, and the result is a homogeneous solution. Thymene or thyme essence, if present, will separate and float as an oily layer on the surface.

Note on **veratrine.**—M. Lepage.—Veratrine with sulphuric acid in large excess gives first a yellow color which soon passes to a permanent blood-red. Some centigrammes of veratrine added to hydrochloric acid and boiled develop a fine purple-red color. E. W.

Le Technologiste.

No. 405.

On the **agents for removing hair** and cleansing in tanning, especially sodic sulphide.—M. Eitner.—The old mode of effecting this amounted to soaking the hides in a vat until a superficial decomposition had taken place. This method is objected to on the ground that the leather is thereby weakened in quality. Various chemicals, as acids, lime, etc., are objected to as injuring the fineness and strength of the leather.

Rapid **desiccation of hard glue.**—H. Fleck.—By placing the cakes of glue when in the form of jelly on a layer of some hydroscopic salt, drying is more quickly effected, and the decomposition which sometimes occurs with moist glue is prevented. E. W.

Bulletin de la Société Industrielle de Mulhouse.

June, 1874.

Analysis of a **new mineral allied to brimite.**—W. Trechsel.—This mineral was found to be $3(PbS).As_2S_3$. Brimite (Dufreneysite) is $2(PbS)As_2S_3$.

Notes on the history of the **theory of turkey red** on cotton fabrics.—A. Romigialli.—Goods dyed with turkey red were found to yield to carbon disulphide a red coloring matter, alumina, and a fatty body. If the fatty body, however, was previously removed by treatment with alcohol, the red coloring matter would not dissolve in the disulphide. It is believed that the fatty acids used in the production of turkey red undergo an oxidation which converts them into this modification.

Note on the **estimation of tin salt.**—F. Goppelroeder. —A given amount of standardized solution of potassic bichromate is added to a weighed quantity of tin salt, and hydrochloric acid, and the excess of bichromate not reduced, is estimated by passing the chlorine evolved into a solution of potassic iodide, in which the iodine set free is determined by titration with a standard sodium hydrosulphite solution.

August.

Note on **fixing Prussian blue** with an alkaline solution of ammonic tartrate.—A. Scheurer.—The proportions for a dark blue are—

Tartaric acid . . .	50
Ammonia	190
Water	150
Dry pulverized Prussian blue	110.

The tartaric acid prevents the decomposition of the Prussian blue by the ammonia. A sample of goods printed with this preparation accompanies the paper.

Note on the **ferri- and ferro-cyanide of aniline.**—M. Wehrlin.—Aniline ferrocyanide gives on steaming a black on goods. The idea was presented some ten years ago, but on account of some practical difficulties was thrown aside. The author prepares hydroferrocyanic acid by precipitating potassic ferrocyanide with tartaric acid, and dissolves the aniline in the acid thus obtained. The salt is quite soluble in water, but is decomposed by boiling heat.

For applying to goods it should be mixed with both roasted and with white starch for thickening, and ammonic chloride and potassic chlorate. The ferricyanide is prepared in a similar manner. It gives deeper and more brilliant blacks, but is less permanent.

Note on **aniline ferrocyanide.**—E. Schlumberger.—The method of preparation here recommended is double decomposition of potassic ferrocyanide and aniline chlorhydrate. The proportions given are: Mix 2 kilos aniline with 2 kilos HCl of 19° B., and cool the mixture. Dissolve 2400 grms. yellow prussiate in 4200 grms. boiling water; allow the solution to cool to 56°, and just before it begins to crystallize pour into it the cold solution of aniline chlorhydrate. On cooling completely a magma of aniline ferrocyanide is obtained. If long kept the substance will decompose. M. Wehrlin's mode of preparing the salt is criticized as being more expensive and imperfect.

September.

On a new process for a **permanent alkaline blue.**—M. Jeaumaire.—The use of ferrous and stannous tartrates is advised in connection with the indigo.

Note on the **preparation of vermilion** by means of hyposulphites, and its application to fabrics.—M. Jeaumaire.—The modes of forming vermilion by this method are given. They are, action of a caustic alkali on an intimate mixture of sulphur and mercury; dissolving mercury dioxide in sodic hyposulphite, and heating for some hours; and mixing sodic hyposulphite with a solution containing ammonic and mercuric chlorides, and then heating for some time. Vermilion cannot be printed on goods, on account of the amalgamation of the copper cylinders which ensues. Its application in other ways is also attended with many difficulties. E. W.

Berg- und Huettenmœnische Zeitung.

No. 24, 1874.

The smelting of iron ores with lignite.—R. von Reichenbach.—The author, after reviewing the projects of Gerstorff, Wagner, Mietsch, Khern, Siemens, and others, for solving this problem, goes on to propose the following plan: 1st. For the older lignites, a blast-furnace of moderate height, with very hot blast (to prevent a sintering of the coal). 2d. With the more recent lignites, to dry them so as to expel all hygroscopic and chemically combined water, and to use these also in low furnaces. 3d. To carry on further experiments as to the coking of the lignites. 4th. Where there are large quantities of fine coal, to use this in one shaft for the reduction of the ore, which is then to be smelted in another shaft with the coarser coal. 5th. In case the preceding methods are not successful, to try a partial or total treatment of the ores with gas produced from the lignites in generators.

No. 31.

Zinc furnace for the treatment of blende.—F. A. Thum.—The writer describes a furnace for roasting the blende by the waste gases of a reducing furnace, and considers the advantages to be the increased yield, the simplicity, and the saving of coal. F. P.

Annales des Mines.

No. 1, 1874.

Notes on the **argentiferous lead ores of Utah**, and their metallurgical treatment.—P. L. Burthe.—The author, after describing the occurrence of the ores, passes to the method of treating them. This consists in smelting the ores with coke or charcoal (frequently with both), as well as limestone or slags from the same process, and generally with the addition of hematite, in a Piltz furnace. The coke is transported from Connellsville, Pa., the hematite from Rawlins, Wyoming Territory. The author very justly calls attention to the great loss of metals, due to the wretched manner in which most of the furnaces are worked, and to the lack of condensation chambers. He also thinks that a greater pressure of blast than is common should be used. Finally, the Flack system of separating zinc from lead in the Parkes process is described, as carried on at the Germania works. Also the English method of forming a copper-matte; separating the silver-lead alloy by liquation. The mattes are treated for copper. The slags are treated in a blast-furnace to recover the silver and lead they contain. This copper process is carried on at the Warm-Springs works, near Salt Lake City.

Researches on the **texture of iron.**—Janoyer.—The author claims that the difference between granular and fibrous iron is due to the temperature at which they are worked in the forge or puddling-furnace, and at which they pass through the rolls; a high heat favoring the production of granular iron, as it permits a more perfect welding and the expulsion of the slag.

No. 2.

Notice on the **argentiferous ore deposits of the United States**, their exploitation and metallurgical treatment (first part).—P. L. Burthe.—This article, which is exclusively devoted to ore deposits, treats of those on the Comstock lode, at Austin, Nevada, and in Colorado. As an abstract of this article is foreign to the *American Chemist*, the reader is referred to the original. F. P.

RECENT CHEMICAL PATENTS.

October 6th, 1874.

155,572.—Methods of Preserving Animal and Vegetable Substances.—G. A. Danet and P. E. C. Feiullant, Paris, France. Slight desiccation and treatment with atmosphere of sulphurous acid and air purified by fire.

155,577.—Gas-Furnaces for Manufacturing Iron and Steel.—W. S. Gillen, Pittsburg, Pa.

155,632.—Making Hard-finished Surfaces.—W. Arronguier, Worcester, Mass.

155,700.—Electroplating Baths.—E. Boy, New York, N. Y.

October 13th.

155,802.—Processes of Destroying Vegetable Matters in Wool and Woollen Fabrics.—F. R. Joly, Paris, France. Treated with chloride of aluminium.

155,816.—Processes for Manufacturing Products from Animal Fats.—G. B. Van Brunt, San Francisco, Cal.

155,872.—Manufacture of Illuminating-Gas.—W. M. Jackson, Providence, R. I. Steam decomposed by passing through a porous material charged with a heavy hydrocarbon.

155,948.—Apparatus for Separating Borax, Salt, etc., from Water.—O. Holden New York, N. Y.

155,990.—Methods for Preparing Flag for Use in the Manufactur of Artificial Stone.—W. R. Smith, Philadelphia, Pa.

October 20th.

156,009.—Chemical Compounds for Facing Metals.—J. E. Atwood, Pittsburg, Pa. Borax, sal-soda, plumbago, charcoal, or other facing powder.

156,051.—Embalming or Preserving Dead Bodies.—T. H. Whitehouse, Indianapolis, Ind. Charcoal, sulphate of iron, hypermanganate of potassa, soft water.

156,056.—Ice Machine.—F. V. De Coppet, New Orleans, La.

156,058.—Apparatus for Draining and Filtering Sugar.—S. S. Hepworth, New York, N. Y.

156,103.—Utilization of the Waste of Paper Manufacture as an Anti-incrustor for Steam-boilers.—Th. Routledge, Ford, near Sunderland, and W. H. Richardson, Springwell-Jarrow-on-Tyne, Eng.

156,152.—Asphalt Pavements.—E. E. Glaskin, Boston, Mass.

156,172.—Processes and Apparatus for the Manufacture of Illuminating-gas.—George Olney, Brooklyn, N. Y.

156,180.—Refining Lead.—W. A. Shaw, New York, N. Y.

156,181.—Recovering Phosphoric Acid and Purifying Ammonia.—J. E. Siebel, Chicago, Ill.

October 27th.

156,220.—Manufacture of Iron and Working and Welding of Steel.—A. T. Hay, Burlington, Iowa.

156,243.—Reducing Ores.—N. W. Wheeler, New York, N. Y.

156,352.—Manufacturing Solidified Collodion.—J. S Hyatt and J. W. Hyatt, Newark, N. J. Pyroxylene, camphor, and alcohol.

156,353.—Manufacture of Celluloid.—J. W. and J. S. Hyatt, Newark, N. J.

156,354.—Factitious Ivory.—J. W. and J. S. Hyatt, Newark, N. J. Ivory or bone dust, pyroxylene, powdered camphor, and nitric ether.

156,379.—Writing Inks or Fluids.—J. M. Reams, Durham, N. C. Extract of Logwood, bichromate of potassa, prussiate of potassa, alcohol, water.

November 3d.

156,404.—Processes of Bleaching and Clarifying Fats.—J. F. Babcock, Boston, Mass. Sulphuric acid, permanganate of soda, and water.

156,464.—Apparatus for Treating Ore-pulp.—A. Patchen, Westfield, N. Y.

156,483.—Processes for Restoring and Purifying Caustic Alkali.—S. Hanna, Jersey City, N. J.

156,537.—Composition Roofs.—E. Churchill, St. Thomas, Canada. Water-lime, slaked-lime, salt, mica, and sand.

156,596.—Manufacture of Steel.—M. Rush, Atlanta, Georgia. Decarbonized iron treated with carbonate of ammonia and common salt.

156,617.—Making Vinegar.—D. Wimpfheimer, New York, N. Y.

November 10th.

156,717.—Paint Compounds.—J. B. Tascott, Chicago, Ill. Glue, borax, sal-soda, ground sulphate of lime, oil, and water.

156,739.—Treating Cobalt Ore to obtain Smalt, Zaffre, etc.—J. L. Klinschmidt, St. Louis, Mo.

156,751.—Apparatus for Separating Oil and Fatty Matters from Water, etc.—J. C. Bates, Providence, R. I.

November 17th.

156,886.—Artificial Leather.—Xavier Karcheski, Belleville, N. J.

156,946.—Compositions for Fire-brick, Stove-linings, etc.—Ernst H. Richter, Taunton, Mass. Fire-clay, shells, and lime.

157,054.—Explosive Compounds.—Joseph W. Williard, San Francisco, Cal. Carbonate of magnesia, nitrate of potash, chlorate of potash, sugar, and nitro-glycerine.

November 24th.

157,083.—Fire-proof Paints.—J. C. Smith, Dunkirk, N. Y.

157,143.—Explosive Compounds.—Carl W. Volney, Boston, Mass. Naphthalene, nitric and sulphuric acid. Oxidizing agents are saltpetre and sulphur.

December 1st.

157,285.—Compounds for Preventing and Removing Scale in Steam-Boilers.—L. E. Hurd, Indianapolis, Ind. Carbonate of soda, oak-bark, pulverized charcoal, chloride of ammonium, linseed-cake, alum, sassafras-bark, and potato-starch.

157,312.—Composition for Artificial Stone.—F. W. Colby and E. Evans, Streator, Ill. Hydraulic cement, silicate of soda, sugar, sand, and gravel.

157,408 —Manufacture of Whiskey.—O. Marland and J. G. Crosman, Boston, Mass. Treat the grain at a temperature between 212° Fah. and that temperature at which the grain would be scorched before distillation.

157,418.—Paving Compositions.—W. C. Porter, Bridgeport, Conn. —Tar, sulphuric acid, lime to saturation, and linseed oil.

December 8th.

157,446.—Processes for Preserving Meat.—J. F. Giles, Chicago, Ill.

157,509.—Anti-friction Metals.—J. K. Guile, Rochester. N. Y.—Zinc, tin, and antimony.

157,510.—Processes for Coloring Enamelled Photographs.—J. Gurney, New York, N. Y.

157,511.—Artificial Stone.—C. E. Hall and E. J. Salisbury, Chicago, Ill. Sand, gravel, and cement mixed with baryta, glycerine, and lime-water.

157,624.—Processes of making a Mixed Paint and Paint-Oil.—J. M. Merryman, Chicago, Ill.

BOOKS RECEIVED.

Jahrbuch fuer des Berg und Huettenwesen im Koenigreich Sachsen. Freiberg, Saxony, 1874.

This annual, which has been published for the forty-eighth time, contains the usual statistics on the mines and smelting works of Saxony, a catalogue of the officials employed; also a notice of the Freiburg Mining School, and at the end some memoirs. It contains the following data about the famous Frieberg metal-mining district: Of 93 mines authorized by the Government, 39 are not worked, 56 demand money from the stockholders, 5 just pay expenses, and 5 pay dividends. The stockholders of some of the mines not worked had to pay old deficiencies. The calls on the stockholders were from $5000 to $27,000, the dividends were from $2560 to $72,000. In the metal mines the death-rate for 1872 was 0·8 per 1000, in coal mines 2·065, in lignite mines 2·122. The memoirs contain notices of Saxon minerals, by Prof. Weisbach; the effect of the new German monetary system on the Freiberg silver mines, and the relief-society laws in the smelting works, by C. G. Gottschalk; and an obituary of August Breithaupt, the distinguished mineralogist.

Geological Survey of Michigan Upper Peninsula, 1869–1873.—Part I. Iron-bearing Rocks, Economic, T. B. Brooks; Part II. Copper-bearing Rocks, R. Pumpelly; Part III. Palæozoic Rocks, D. C. Reminger. 2 vols. 4to. cloth. Illustrated and folio atlas of 23 maps in sheets.

Tables for the Determination of Minerals by those Physical Properties Ascertainable by the Aid of such Simple Instruments as every Student in the Field should have with him. Translated from the German of Weisbach. By Persifor Frazer, Jr., A.M. 12mo. leather. Philadelphia, 1875.

Butter—Its Analysis and Adulteration, specially treating on the Detection and Estimation of Foreign Fats. By A. Angell and O. Hehner. 8vo. London, 1874.

Manual of Precious Stones and Antique Gems. By Hodder M. Westropp. 8vo. cloth. Illustrated. London, 1874.

BREVITIES.

At a recent meeting of the Chemical Section of the New York Lyceum of Natural History, Dr. H. C. Bolton made some remarks on certain points in theoretical organic chemistry. In particular he referred to the derivation of alcohols and acids from hydrocarbons, by successive substitutions of (OH)′ for H, and O″ for H_2. After showing the importance of the group COOH (*carboxyl*) to the formation of an acid, he maintained that the group CHOH is equally necessary to the existence of an alcohol, and proposed for this group the name of *carbhydral*.

He then explained, using Kekule's six-carbon-atom-ring, why the so-called carbolic acid, or phenol, is no true alcohol, the group *carbhydral* being wanting. Phenols therefore are bodies peculiar to the aromatic group, and have no analogues in the fatty group. Ringing the changes on the graphic formulæ, he showed how the true alcohols and acids of the aromatic group are derived, viz., by effecting the substitution in the methyl group. Thus, benzoic acid is really derived from toluol, which is methyl-benzol. He alluded to the relation which phthalic and salicylic acids bear to this series.

Water-proof Varnish.—Klein & Smidt.

Caoutchouc dissolved in turpentine.....	500	parts.
Dry gutta percha.....	240	"
Rosin.....	100	"
Whitelead.....	200	"
Turpentine.....	400	"

New System of Filtration.—Prof. C. A. Seely has described a "New System of Filtration." The ordinary mode of filtration is defective, in that one-half of the paper employed is not utilized, and that the process is somewhat obstructed by contact of the paper with the funnel. These and other objections are obviated by the devices proposed. For the funnel a tube is used, an inch or more in diameter, and about ten inches long. The lower end of the tube is covered with filtering paper, held in place by a piece of Swiss muslin, fastened by a rubber ring or stout twine. The upper end of the filter-tube has a rubber-cork, carrying a small rubber tube which leads to a simple pressure apparatus. To support the tube, a rubber ring, fitting it, is stretched over an upright rod of peg set into the table or shelf. The rapidity of filtration may be changed at will by varying the diameter of the tube and the pressure.

Manufacture of Fertilizers.—M. Ladureau proposes to expose woollen waste to a mild degree of heat, thus producing a brownish powder, with a faint odor of chicory, to be employed as a fertilizer. This contains from 6 to 8 per cent. of ammonia and 1 per cent. of potassa. This is mixed with superphosphates, so that the commercial article contains—

Soluble phosphate of lime.....	7 to 8	per cent.
Salts of ammonia.....	9 to 10	"
" potassa.....	5 to 6	"
" magnesia.....	½ to ¾	"

White Glass.—One of the most interesting and important kinds of colored glass, says Fischer, in the *Glashütte*, is the so-called "bone-glass," and yet very little has been said about it in glass literature. Cryolite has effected as great a revolution in the manufacture of white glass as petroleum has in the means of illumination. What part the chief constituent of the bone, the phosphate of lime, played in the manufacture of bone-glass was not exactly understood, and a still thicker veil is drawn over the action of the fluoride of lime, soda, and alumina, known as cryolite. It is to offer some explanation of this action that Fischer takes up this interesting branch of the glass industry. Phosphoric acid is, at high temperatures, a very powerful acid—so much so that no other acid is able to replace it. Hence we may reasonably suppose that the phosphate of lime remains suspended, as such, in the molten mass of glass. This, too, is indicated by the fact, that when an excess of bone-dust is added to the glass, or on suddenly cooling it, it is rough on the surface; but if the glass has the proper constitution it remains perfectly smooth. How may the action of cryolite be explained? The power of hydrofluoric acid to etch glass and render it matt is well known, and depends upon the decomposition of the silicates, taking from them a part of the silica, and the soda or potash, so as to form a compound known as fluosilicate of soda or potash, and then flying off in the form of a vapor. We all know that this takes place, to a greater or less extent, in every cold, completely-formed glass; how much easier and better would this process take place under the ægis of heat, that prime mover of all chemical reactions, so that the phenomenon referred to appears to a greater degree of intensity in the process of fusion, and the gas evolved exerts a highly destructive influence. Bone glass may be painted and ornamented, but unfortunately, under some circumstances, it turns black in spots during this operation. This is called "striking out" by the workmen. All attempts to remedy this have proved in vain; no scientific explanation has been given, and no practical means of avoiding it have been discovered.—*The Engineer.*

Titanium in Iron Ores containing Phosphoric Acid.—E. H. Bogardus has found that by fusing titanic iron ore, containing phosphorus, with bisulphate of potassa, and reducing the water solution of this with sulphuretted hydrogen, a mixture of phosphoric acid, titanium, and iron is precipitated with the sulphur. He, therefore, recommends that the sulphur be tested for titanium, if none is found upon boiling the filtrate for the sulphur.—*American Journ. Science.*

Elie de Beaumont died September 24th, at the age of seventy-nine.

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NEW PROCESSES IN PROXIMATE GAS-ANALYSIS.*

BY HENRY WURTZ,
Of New York.

Gas-analysis, in the widest and highest sense of the expression; comprehending the proximate analysis of gaseous mixtures, natural and artificial, as well as the ultimate analysis of gaseous compounds; includes what have heretofore been unquestionably the most difficult and delicate, while also, when correctly viewed, the most fruitful and promising branches of laboratory chemistry. It is also quite just to assert of these branches that they have of late years been far too little cultivated by many chemists of the first rank. It is to this that I would attribute the fact that your own great and noble art of Artificial Illumination—to which I might add those of metallurgy and furnace operations generally—lingers in a stage of empiricism not in accordance with the actual advancement of chemical science. It may safely be alleged that we are now learning far more, and more rapidly, of the liquid and solid products of retorts and furnaces, than of the gaseous products. This should not continue; and I venture to hope that the observations I have to offer may in some measure lead the way, and to some extent lay the foundation, for the more diligent application of known chemical principles to the practical investigation of gaseous mixtures and products of the chemical arts.

The class of methods, known by the rather insignificant name Eudiometry, had so great an impulse imparted it a quarter of a century ago by the genius of the illustrious Bunsen, that gas-chemists have really seemed to merit since, in some measure, the reproaches cast upon the immediate disciples of Aristotle of old, who believed their great master had probed the depths of possible human wisdom, and therefore refused to interrogate nature further. It is true that many of Bunsen's methods, apparatus, and manipulations in gas-analysis, will remain indispensable, and will stand as monuments to his fame; very little having been done since except in the way of modification, by other chemists; but there are nevertheless cases and conditions often of great importance, where all so-called eudiometric methods fail to satisfy the practical requirements.

One such case may here be entered into as an example. This is the determination of *air* as a contamination of illuminating-gas. It is well understood that each single proportion per 100 of air destroys at least six per cent. of the illuminating value of an ordinary coal-gas. It is not easy then to exaggerate the importance of this case. But, in a eudiometer 500 millimetres long, one volume per 100 of air is but one millimetre of oxygen. A variation or error of observation of a single degree Fahr. of temperature, or of ·061 inch of barometer, down or up, will either double or destroy this determination. But by the methods I have now to propose, one cubic foot of such gas will yield, in a form amenable to the balance, 1·18 grain = ·076 gram. of oxygen; and 5 cubic feet ·3815 gram.

Moreover, in eudiometric oxymetry, the introduction of potassic pyrogallol into the gas under investigation, is always of necessity preceded by that of potassic liquor or potassic hydrate, to remove carbonic acid; and if this potash be washed out with water, say with a minimum of 20 millimetres (in a eudiometer of 500 mm.) of the latter, this water will always abstract some of the oxygen sought to be determined. At 60° F. = 16° C., 20 mm. HO can take up (Bunsen) ·59 mm. of O; or, in this way, as much as 59 per cent. of the oxygen (and air) sought may be altogether lost! I may add that in working on coal-gas the further possible, or at least supposable absorption, by this 20 mm. HO, of ·29 mm. of N, ·39 mm. of H, and ·48 mm. of CO gases—together with the ·59 mm. of O—1·75 mm. in all—might vitiate the CO_2 determination to the extent of 0·35 per cent. of the whole volume, in excess; which, in a coal-gas purified by lime, would be a vitiation quite fatal to the value of the analysis.

Some eudiometrists may reply that they do not wash out the potash with water before applying pyrogallol. If so I must impugn their work on several other grounds: for instance, will the film of potash liquor on the inner wall of the eudiometer occupy the same volume as a film of pure water? My own experiments have shown me that it will not. Again, either solid potash or strong potash-liquor desiccates the gas, thus introducing another very appreciable error. A conscientious original investigator, who tests all methods rigidly himself, will devise ways to mitigate, if not to eliminate, some of these difficulties but this does not meet the practical requirements of the case, for all are not competent to do this.

The above is cited as but one sample of the multitude of difficulties with which every really competent eudiometrist must admit himself to be environed.* Special and complex devices have not been wanting—many of them of great and permanent value—to lessen certain difficulties; but it has appeared to me that in those cases —including many of the most important ones, as, for example, illuminating-gases, and gaseous furnace-pro-

* Communicated in part, with experimental illustrations, to the American Gas-Light Association, October 22, 1874. Revised and corrected for this journal by the author.

* I may be excused for here introducing the remark that I myself have endeavored to do my share with other gas chemists towards the emendation of Bunsen's system of eudiometry. My own efforts have been generally in the direction of simplification, and more especially to attain (what I have always deemed) the great desideratum of the reduction of the needful amount of quicksilver to a minimum. I now use simple devices and manipulations which enable me to accomplish all the essential work of eudiometry with, at the most, 10 lbs., and chiefly with not more than 5 lbs., of the liquid metal. These will soon be submitted to the chemical world. —H. W.

ducts—in which the mixture to be analyzed is attainable in volumes practically illimitable, it would be well to try to cut loose from methods which are purely volumetric, and to devise such new ones as would enable us to deal with quantities that can yield ponderable products; thus appealing directly to that infallible criterion, the chemist's "court of last resort," the balance.

In this attempt I have already met with success sufficient to encourage me to put forth the results before the chemical world, confident that some things will be recognized in them worthy at least of being followed up and brought to a further stage of perfection. This further pursuit of these paths of promise will be my own task, so far as it may be permitted to me.

The methods I now put forth are founded on the general principle of submitting a slow current of the gas to be investigated to the action of a series of agents, so selected and combined as to absorb and separate, in succession, each by itself, the different proximate constituents of a gaseous mixture, converting each into a solid or a liquid form, which can be weighed on a balance. About 1840, European chemists were using successfully methods of this class. One method which arose at that time out of their experiments in this direction, was that still in use in "organic analysis," for separating in distinct and weighable forms water and carbonic acid. Strangely, however, the capabilities of these methods seem to have been looked upon as very narrow and special, and they have passed almost out of view. At the present day it is probable that a majority of chemists would not have anticipated in advance much satisfactory success in the application of these modes of procedure to such complex mixtures as crude coal-gas or a furnace-gas. My experience has, nevertheless, tended to an opposite conclusion, and I believe that I discern in this direction the only practicable road to complete success in the proximate analysis of heterogeneous gases.

[In this memoir, I will here say, I must confine myself mainly to illuminating gases. The handling by these methods of furnace-products will furnish subjects for future communications.]

In a crude coal-gas, as drawn from the hydraulic main, over the retort-benches, the following main constituents may be enumerated, which it is highly important that a gas chemist should be competent to separate and determine with precision :—

1. Tar, suspended in the form of spray.
2. Water, in similar mechanical admixture.
3. Water, as vapor, dissolved in the gas.
4. Naphthalene (condensable).
5. Other condensable hydrocarbons.
6. Smoke and soot (with dust).
7. Ammonia.
8. Carbonic acid.
9. Sulphuretted hydrogen.
10. Carbonic oxide.
11. Oxygen, that is, intermixed air.

Of these seven proximate constituents I have so far succeeding in separating, with very satisfactory sharpness, Nos. 1, 2, 3, 6, 7, 8, 9, and 11; eight in all, besides some approximation to No. 4, the naphthalene in excess. No. 10, the carbonic oxide, is still a subject of experiment; No. 5 also.

My success so far is to be attributed mainly to the gradual attainment, and combination by tentative experiment, of the following devices and manipulations.

First, arresting suspended matter by means of empty dry flasks and straining through cotton previously *desiccated*.

Absorbing next the ammonia by means of reagents which act on no other ingredient.

Next, drying the gas with CaCl, which, NH_3 being absent, may now be done.

Next, taking up the sulphuretted hydrogen by a normal metallic salt, so selected or so managed as to give up no water or acid vapor to the desiccated gas.

Next, using sodic hydrate to absorb the CO_2, with certain precautions described below.

Next, alkalized pyrogallol or other suitable agent, to absorb oxygen, arranged so as to lose no water.

In the case of illuminating gases—with some few others—the final (rough) measurement of the gas is then made at an observed temperature by a gas-meter; if with a dry meter, directly; if with a wet meter, after saturation with moisture at the temperature of melting ice.

In the latter case, of a wet meter, the amount of final moisture in the gas is determined by a reiterated desiccation with CaCl.

The whole process is finally completed and the separations rendered as sharp as may be, by a process of distillation, either at the ordinary or higher temperature in a current of the same gas analyzed, that has been previously subjected to the same or similar treatment, and thus freed from all the ingredients to be separated from each other.

After final weighings, the *correct* initial volume of the gaseous mixture is calculated by certain formulæ derived, as specified below, from the crude meter-indications and the final weighings.

I shall now proceed to an attempt to explain simultaneously, to save space, the details of the methods as applied to each constituent, and those of the construction, preparation, and arrangement of the different pieces of apparatus, as connected and represented in the figures.

I. Analysis of Crude Gas, in the Gas-House before Purification.

The mechanically suspended Tar and Water.—The joint devices for arresting these two substances, in the first instance, are shown in Fig. 1, letters A to F inclusive. A indicates an inch-thick soft-rubber cork, with two perforations, occupied respectively by a thermometer and an eduction-tube bent at a right angle, inserted into an aperture bored through the wall of the hydraulic main or of any other main in the works. The eduction

tube must at once descend, to allow liquids to flow into the flask, and must have a stopcock in it. The first member of the train is an empty dry thin glass flask C, which collects almost the whole of the spray, aqueous and tarry. DD are two stoppers for closing C hermetically, constructed of pieces of rubber tube closed at one end by short sections of glass rod. The bent wires by which these are permanently attached to the flask had better be of iron than of copper, as they are to be weighed with the flask, and the latter metal is quickly

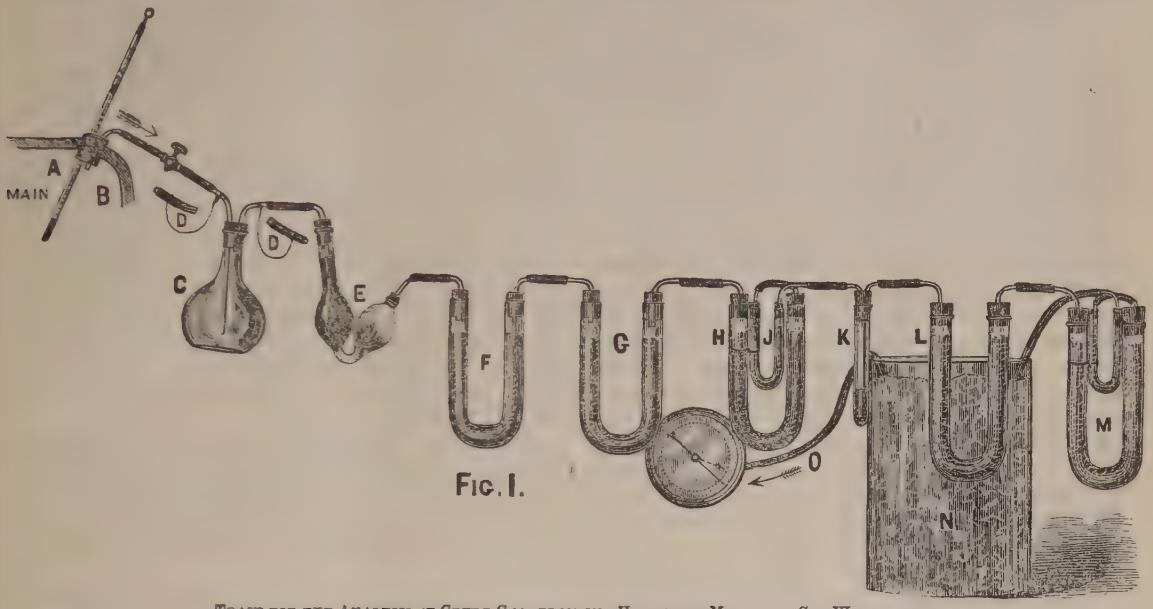


FIG. I.

Train for the Analysis of Crude Gas, from the Hydraulic Main of a Gas Works, etc.

Note.—Between G and H an additional tube, precisely similar to G, charged with *chloride of calcium*, is employed, which for simplification has been omitted from the figure.

blackened and may be slightly changed in weight by the sulphide of ammonium that pervades the atmosphere of the gas-house. In a permanent apparatus, for nicety, platinum wires had better be used. Copper wires, however, used here, and in other parts of the apparatus, may be protected pretty well by coating with collodion, or even with a film of paraffine. [All the brass stopcocks I use in these and all other operations with sulphuretted gases, I prefer to plate, inside and out, with nickel; which protects them perfectly against sulphur. This nickel-plating, every gas-chemist will find it worth his while to perform for himself, as it is *very* easy to accomplish, in case of brass and copper surfaces, with slight practice. I propose publishing a note which I think will lead any laboratory worker to success in his first trials.]

These trains of apparatus are probably most conveniently set up by being suspended to a strong wire—best of soft copper—stretched tightly between two convenient points of attachment. To make this wire tense or "taut," it had better be in two pieces, attached first at the extremities, then twisted together strongly and warily with pincers at the point of meeting. The tubes are hung on inverted V-shaped (Λ) wires bent into hooks below. These, for simplicity, are not figured. All the rubber tubing used as connectors, I wash laboriously, internally and externally, in a rapid current of water, with hard rubbing between the hands, until absolutely clean, then rub dry, and lubricate, within and without, with thick syrupy glycerine. The excess of this being wiped off, the tubing is found permanently more flexible, far less liable to abrasion of surface, more easily slipped over ends of glass tubing, and, above all, has its capacity for absorbing certain constituents of the gas reduced to a minimum. All the corks should be rubber, scoured and glycerated superficially in the same way. The cork at A—owing to the heat and actual contact with tar—and, to a less extent, the cork of flask C, are somewhat penetrated and softened, so that A gives out, after being used a number of times. The others last indefinitely.

E and F are stuffed, uniformly, but as loosely as practicable, with cotton, which is best inserted and gently packed down, in successive small wads, picked out before insertion. The bulbous pattern, like E,* may present here some advantage, but it is not at all essential. Its use, as photographed in this case, was in order to bring down somewhat the level of the rest of the train. I have used, and prefer, a compound cotton apparatus, or two tubes of the size of F, united by a twisted wire

* I may say here that E, as shown in the cuts, was in the condition left after having been used; and in drawing from the photograph, an attempt has been made, none too successfully, to reproduce the shading of the condensed soot.

in the manner of A in Fig. 4. These can be weighed together conveniently.

Even in case of a gas that has passed through condensers and scrubbers, it seems necessary to use two tubes of cotton. In one actual series of analyses, of unpurified coal-gas before and after having passed the scrubbers and condensers, the second tube F increased, on an average, in weight (all moisture having been removed), from the uncondensed gas ·128 grain, and from the condensed ·072 grain, per cubic foot of gas passed, up to 7 cubic feet. The main consideration here is the initial *pressure* at command, of the gas. If the customary exhauster is employed in the gas works, and kept at work during the analyses, the pressure between the exhauster and the retorts may be found so low that a train attached between these, may not admit of more than one cotton tube, and even this packed as loosely as possible. At points beyond the exhauster, however, this trouble seldom occurs; it having been necessary, indeed, in some such cases, with unpurified gas, to partially close the cock in the eduction-tube, to bring down the rate of flow through the train to about one cubic foot per hour, which it should not in most cases exceed.

The Ammonia.—In order that we may employ, for dehydration, the highly convenient, powerful, and reliable agent, chloride of calcium, it quickly became apparent to me, in my earliest experiments, that the ammonia must first be abstracted from the gas; and my first efforts were to decide upon the proper agents that could be used, in solid form, for this absorption. One of these I have so far sufficiently tested, by quantitative as well as qualitative experiments, to demonstrate its entire applicability to this use; namely fused *potassic bisulphate.* It is proper for me here to state that the earliest preliminary experiments with the bisulphate were made, at my suggestion, in the course of an investigation carried on jointly by Prof. B. Silliman,* Dr. S. D. Hayes, and myself, in which we desired to absorb the ammonia of crude coal-gas. We all became convinced, I believe, that potassic bisulphate had the power to take out *qualitatively* the NH_3 from gas; but the precautions, essential to success, in the quantitative way, have been since worked out by myself alone.

The mode of preparation of the bisulphate is by simply cracking in a mortar to the average size of wheat-grains, and removing the dust and finer particles by a sieve of eight holes to the inch. The dust is very painfully irritating and injurious, and its inhalation must be avoided, if possible.

[Though many chemists seem somehow to have acquired the idea that bisulphate of potash possesses more or less *deliquescence*, it in reality has none of this quality whatever, and it is not even hygroscopic to any remarkable extent.]

* Prof. Silliman has also since worked by himself on this or a closely related subject, and made a communication to the National Academy, at the late Philadelphia meeting, to which I would refer. Prof. S., I believe, experimented chiefly on the utilization of crude commercial bisulphates, generally of soda, called "salt-cake" in commerce, for the technical extraction of ammonia from gas.

It must not be supposed that the bisulphate takes up ammonia as NH_3, which would involve a very important error. The compound formed, as desiccated for the final weighing, is the double sulphate of potash and oxide of ammonium. The factor *am* in the equations below must be obtained, from the increase of weight, by multiplying by a coefficient = ·70833. And it may here be remarked that a part of another factor, *wv*, comes likewise from this increase of weight, through multiplying it by ·29267. This ammonia tube is lettered G.

The Water.—Chloride of calcium for absorbing this comes next in our Fig. 1 train, though, as it would be merely a duplicate of G, the CaCl tube has been omitted from the cut. I prefer—after trying many preparations—a *fused* chloride, assuring myself, above all, that it is free from every trace of causticity, and crack it up to the size of small peas, sifting out all that passes a sieve of six holes to the inch. For the small CaCl tube J, the one in M (Fig. 1), and J and L in Fig. 4, I find it desirable to crack but little, if any, smaller, to avoid risk of obstruction.

The Sulphuretted Hydrogen.—For this constituent I have tried several absorbents, but none as yet that answers, on the whole, so well as common crystallized blue vitriol, cracked and sieved to wheat-grain size. As in desiccated air it slowly loses some of its water (Graham found that in fine powder, over oil of vitriol, it lost in seven days three of its five water-equivalents) I add a small CaCl tube, which is, of course, weighed with it in all cases. The test-tube K, containing a slip of lead-paper, belongs (qualitatively) with the cupric-sulphate tube H.

With crude gas from highly sulphurous coals it may sometimes be prudent to duplicate this member of the train. Of course the small CaCl tube J need be added only to the second one. The whole increase of weight in this member is HS. If to be calculated as simple sulphur, as sometimes required, it must be multiplied by ·9471.

The Carbonic Acid.—The agent which combines, for this absorption, the greatest advantages by far, is that form of sodic hydrate now so common in commerce, cast into pencils, and labelled "soda by lime." In this class of operations the weight of CO_2 to be absorbed is often very large. In ten cubic feet of crude coal-gas containing 2 per cent. by volume of CO_2, there is about 172 grains by weight of the latter, which requires for absorption (if normal carbonate be formed) near 315 grains of sodic hydrate. Although some bicarbonate is usually formed, yet the absorbing surface required is large. Potassic hydrate, prescribed in the books, is wholly out of the question for these methods. The solubility of KO,CO_2 is so great, especially as much heat is always developed during the CO_2 absorption, that the water of the hydrate serves to melt the mass into a magma and quickly to obstruct the flow. In cases where mere abstraction of CO_2, without weighing, is the object, one large tube containing 10 or 12 ounces

of sodic hydrate—as in H, Figs. 2 and 3—may be employed; but in the case under consideration, two tubes must be used, containing each 5 or 6 ounces, to reduce within conveniently weighable limits. These are here lettered L and M.

The soda-pencils are cracked up, a few at a time, by gentle blows in a mortar, to lengths of from ·5 to ·7 inch. This is very rapidly and easily effected; but still a film of moisture is absorbed; and I have found that desiccated gas will then take up from it a trace of water. The precaution is therefore taken to append a small CaCl tube to the second of the two, M. This may be avoided if the Preparatory Train, Fig. 2, be employed to dry out these soda-tubes, before their initial weighing.

The Meter and the Measurement thereby.—This most essential operation of all, is effected with every precaution to insure known conditions of the residual gas. In the case represented in Fig. 1, it is to be understood that a dry meter is used to measure the gas as absolutely freed from moisture, and at, or as close as possible to, the temperature of melting ice. Within N, filled with cracked ice, is coiled some feet of rubber tubing—well *glycerated* internally—and the meter is inclosed—leaving the dial exposed—in an outer casing, not here shown, filled with feathers, or better, with *ice*. In an emergency, muffling the meter in blankets may be resorted to.

The meters used must of course be most carefully tested, and their average errors determined and taken note of. Space cannot, unfortunately, be here spared to explain the modes of effecting this. As it may often be necessary to use wet meters, like those usually found in photometric rooms, I have represented in Fig. 4 a modified mode of measurement, which admits of such use. Here also, the whole meter, except the dial, ought to be protected, as before, from external warmth.

It will be readily understood that when the ordinary photometric meter is employed, as this usually registers but four feet of gas at each revolution, appropriate measures must be taken to mark, or verify, in some way, the number of revolutions, when these are desired or are likely to exceed more than two revolutions in all.

In Fig. 1, as I ought further to explain here, the eduction tube O, which is the prolongation of the rubber coil in N, passes to the inlet aperture of a *dry* meter, and not, as in Fig. 4, below, to the rear of a wet meter.

II. Of the Preparatory Train. (Fig. 2.)

This is employed in the initial drying-out of the apparatus, preparatory to the first weighings; and also for the final completing of the separation preparatory to the last weighings; in the latter case, by the distilling or transferring over, in a current of pure dry gas,

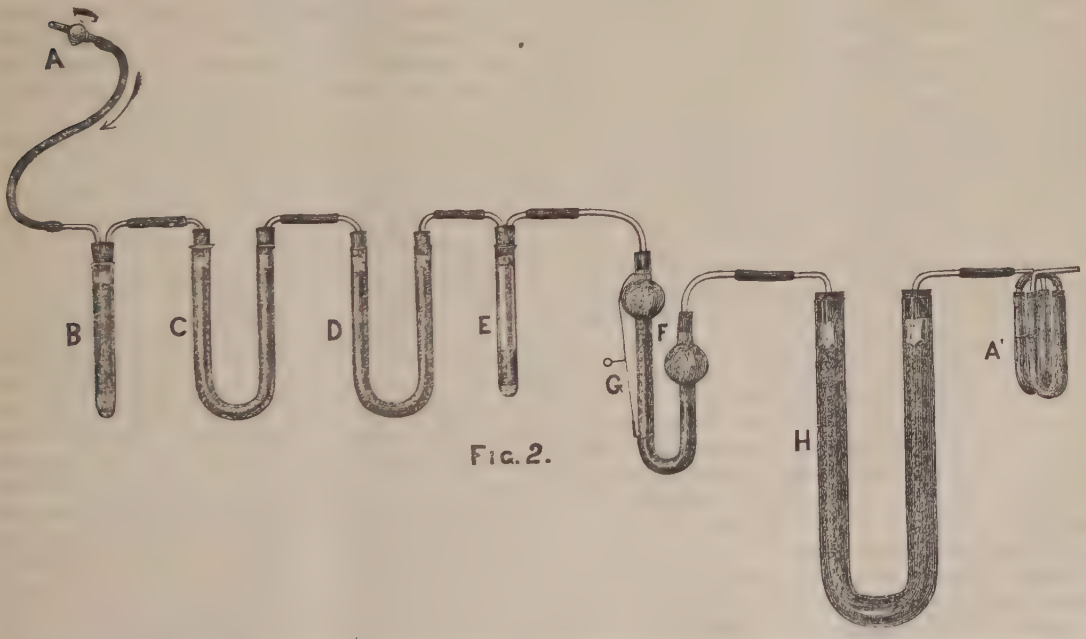


Fig. 2.

Supplementary or Preparatory Train; both for preliminary preparation of the trains for analysis, and for completion of the processes therein.

of the liquids that condense, by mere refrigeration and adhesion, in the first tubes.

It is made up as follows: Stopcock A, in an induction tube from any service-pipe bringing street-gas; test-tube B with inlet tube passing to its bottom, which contains a strip of turmeric paper, to indicate

(qualitatively) ammonia; two U-tubes C and D, containing respectively granulated fused bisulphate of potash, and granulated blue vitriol; a second test-tube E, containing slips of both turmeric and lead-paper, to demonstrate the complete removal by D and E of the HS and NH_3 (the latter by comparison with the turmeric paper in B); a CaCl-tube F; and a sodic-hydrate tube H (of large dimensions, as shown, in cases where the street-gas, through iron-purification or otherwise, contains very much CO_2). [B, in this train, is not at all essential.]

In this figure the Preparatory Train is represented as attached to the first compound member (marked here A′) of the train for analysis of purified gas, shown in Fig. 4. In Fig. 3, H represents the final member of the preparatory train; showing its connection with the train in Fig. 1, during the distillation preparatory to the final weighings.

It may be stated that this preparatory train being required only to furnish a current of gas free from moisture and impurities, it is obvious that the current that issues from one analytical train while in operation, is suitable for the preparation, for either initial or final weighings, of another analytical train, and that this circumstance will at times be available, and lead to saving of trouble in transportation and erection of apparatus.

Another important point of practice with the preparatory train, demands a few words. Its union with the analytical train represented in Fig. 1, makes a long and very tortuous passage for the gas, which necessitates an important *pressure* to force a rate of flow sufficient for rapid work. This is very liable to cause difficulty, with street-gas; particularly during the mid-day hours. It will therefore often be advisable to arrange so as to conduct preparatory operations during the night-hours. Cases occur in which special expedients may be necessary, to procure a sufficient flow. A small gas-holder, when available, may be used. The pressure in the mains between the exhauster and the purifiers, will always be ample to force one or even two cubic foot per hour, through almost any length of (unobstructed) train; but in this case it must be remembered that the preparatory train should possess an extra size and power, and be properly proportioned, to take out the large proportions of impurities present; for if a preparatory train left working with an analytical train over night should become fouled, of course the whole apparatus would be liable to be rendered useless, and the whole time and labor be lost.

It may be scarce necessary to suggest that for these preparatory operations, coal-gas is used only for convenience. With a holder, or an aspirator, a stream of *air*, similarly freed from HO, NH_3, CO_2, etc., is generally equally applicable, and when the pressure has to be assisted, we may, in most cases, just as well use air, if we have the appliances.

III. Of the General Manipulations with Crude Coal-Gas.

In addition to the details which have been given when describing singly the members of the train in Fig. 1, further explanations are needed, especially with regard to the application of the preparatory train thereto. In the preliminary preparation for the *initial* weighings, it is unnecessary, with the arrangement as here represented, to attach more than the first four pieces, to and including the bisulphate-tube G: for reasons which will be obvious without explanation. Some five or six cubic feet of gas transmitted from a preparatory train, will dry out these first four members sufficiently to allow of correct weighing. This will be accomplished by setting and keeping the apparatus at work during one night, say from 5 P. M. till 8 A. M., or 15 hours, at the rate of about 0·3 or 0·4 foot per hour. The rate of flow is readily regulated by a few observations, of ten minutes each, of a meter at the tail of any train. A little practice enables the rate to be judged of closely enough, by the size of the flame burning from a small straight glass tube at the tail of the apparatus, as shown in Fig. 4.

The preparation for the final weighings is here the important part, and indeed the only troublesome part of this analysis. Fig. 3 represents, as aforesaid, the mode of attaching the preparatory train to Fig. 1, for this final operation, or rather succession of operations. D here represents a new tube introduced at this time, which is an ordinary form of CaCl tube, but having its smaller extremity bent at an obtuse angle, as shown, and which contains, near its upper end, a slip of turmeric paper, and has, moreover, running through it from end to end, and projecting an inch at each end, a *small flexible copper wire;* the object of which latter is to clear a passage through the crystals of naphthalene which condense in this tube at a subsequent stage of operations.*

After this disposition of the apparatus has been made —D having been of course *weighed* with its appendages; and the jar of ice N (which is no longer of use) removed, the meter being connected directly with M— the first step is to distil over, at a very low temperature (unless saving time is important, at ordinary temperature) in the current of gas from the preparatory train —which generally in this case may flow even as rapidly as two feet per hour—all the volatile ammonic carbonate and sulphohydrate that has condensed in the flask C and cotton tubes E and F. The volume of gas required to effect this may be double (or even more) that from which the liquid was condensed. It ought to have been stated that the total amount of crude gas analyzed by this apparatus should not exceed ten cubic feet. This volume is within the limits of manageability, but generally somewhat less is probably advisable. With a rapid current of gas, this complete transfer of the

* This wire should have shown more distinctly in the cut, but this is only one of several unfortunate defects in these cuts.

volatile ammonia-compounds will be found to have been effected during 15 or 18 hours; but sometimes more time is required; and it is better to allow 24 hours for this part of the process. If an attempt to hasten it is made, by immersion of the flask in warm water, constant watching is necessary, as *naphthalene* then enters upon the scene, and may at once clog up all passage. The complete transfer of the ammonia is indicated by the return of the slip of turmeric-paper to its natural color. As, in my experience so far, this liquid *always* contains *chloride of ammonium*, and possibly sulphite and other non-volatile ammonia salts, those who wish

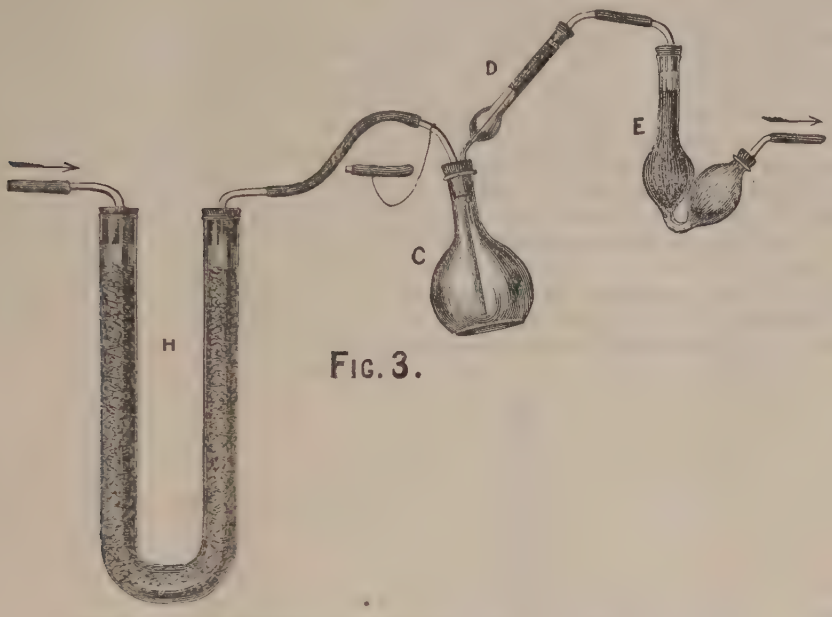


FIG. 3.

Supplementary Arrangement for Completion of Process in the Train shown by Fig. 1.

to transfer *all* the ammonia to the bisulphate-tube G must introduce into the flask a weighed quantity of dry hydrate of soda.

When the ammonia-transfer has been completed, the flask C is immersed—the gas-current being continued—in water sufficiently hot to volatilize the naphthalene, which will condense in crystalline form, together with water, in the tube D. The wire running through D now comes into play; and, in fact, without it, naphthalene would here become as great a cause of difficulty as it often does in the distribution of coal-gas. When clogging occurs, the gas-current is stopped, the rubber connector between D and E detached, and the wire moved up and down or twisted round. With careful management, two hours' work and some two feet of gas from the preparatory train, will suffice to transfer the naphthalene to D, which is then detached and weighed again. To remove the intermixed water from the naphthalene, the lower end of D is stopped, the cork and tube removed from the upper end, the wire coiled within, and this upper end connected by a wide short rubber connector with the open end of a test-tube containing some granulated CaCl. When dry, the cork and tube restored, the stopper removed, and the weight again ascertained; the variation now from the first weight is the naphthalene, so far as it can be saved by this mode, which of course is imperfect, but is the best that I have so far succeeded in devising.*

The flask C, still containing tar and water, is then removed likewise from the arrangement—the stoppers DD (Fig. 1) being applied—and then H of the preparatory train is connected directly with the first cotton-tube E; the gas-flow being resumed. Some five feet more of dry gas may be now required to transfer all the moisture to the CaCl tube between G and H (omitted from the cut). The water and tar in the flask C must be separated by careful distillation at a very moderate temperature, and in estimating the weight of the residual tar, account must be taken of the sodic hydrate that was added, as above, to eliminate the fixed ammonia.

The point at which the whole train becomes dry and ready for the final weighings, is readily perceived by a practised eye. One indication is a faint superficial whitening of some unaltered blue granules (if any) of cupric sulphate in the tube HJ. Several other indications might also be cited.

* Since the above was written, I have discovered that a very appreciable amount of naphthalene condenses, and remains throughout the final desiccation, in the cotton-tubes E and F, and has therefore been rated as solid matter mechanically suspended.—H. W.

IV. Of the General Manipulations with Purified Coal-Gas.

Fig. 4 represents a very complete train for this purpose. As the suspended matter here is absent or trifling in amount, and the ammonia usually very small, A represents a combined arrangement for taking up both these. The first or right-hand U-tube is loosely filled with cotton, the second one with granular bisulphate. E contains two slips, of turmeric and red litmus-papers, to verify the perfect efficiency of the bisulphate. F contains granulated cupric-sulphate crystals. G is CaCl. H is sodic hydrate, with a small CaCl-tube appended. The arrangement KL, for determining oxygen, requires special explanation. K contains glass beads or broken-up glass rod, wet with a concentrated solution of pyrogallol in previously boiled water. L contains CaCl. As, in order that the pyrogallol should take up the oxygen, there must be an alkali present, the following special course is adopted for preparing KL for initial weighing and introduction into the train. K is immersed, L being detached for the time, in snow and salt, and connected with a flask like C in Fig. 1, containing some of the strongest liquid ammonia. A current of common street-gas is then directed first into the ammonia-flask, then through K. The former is warmed, and the gas, as it issues from the latter, lighted. The point of saturation of the contents of K with NH_3 will be indicated by a change in the character of the flame. The ammonia-flask is then detached, L replaced, KL weighed after applying stoppers to prevent ingress of air, and the whole attached to J and put in position.

A, in connection with E, is also dried out before initial weighing of the former, by a current from the Preparatory Train; this operation being greatly accelerated in this case, by immersion of A in the boiling water in B, which is raised up and hung, for this purpose, on the little wire pothook D. It is to be observed that the two tubes in A are weighed separately, and not together; and to avoid hygroscopic moisture, cooled and inclosed while weighing, in close boxes of sheet-brass or tin. The members of this train G, H, and P require no preparatory desiccation before weighing.

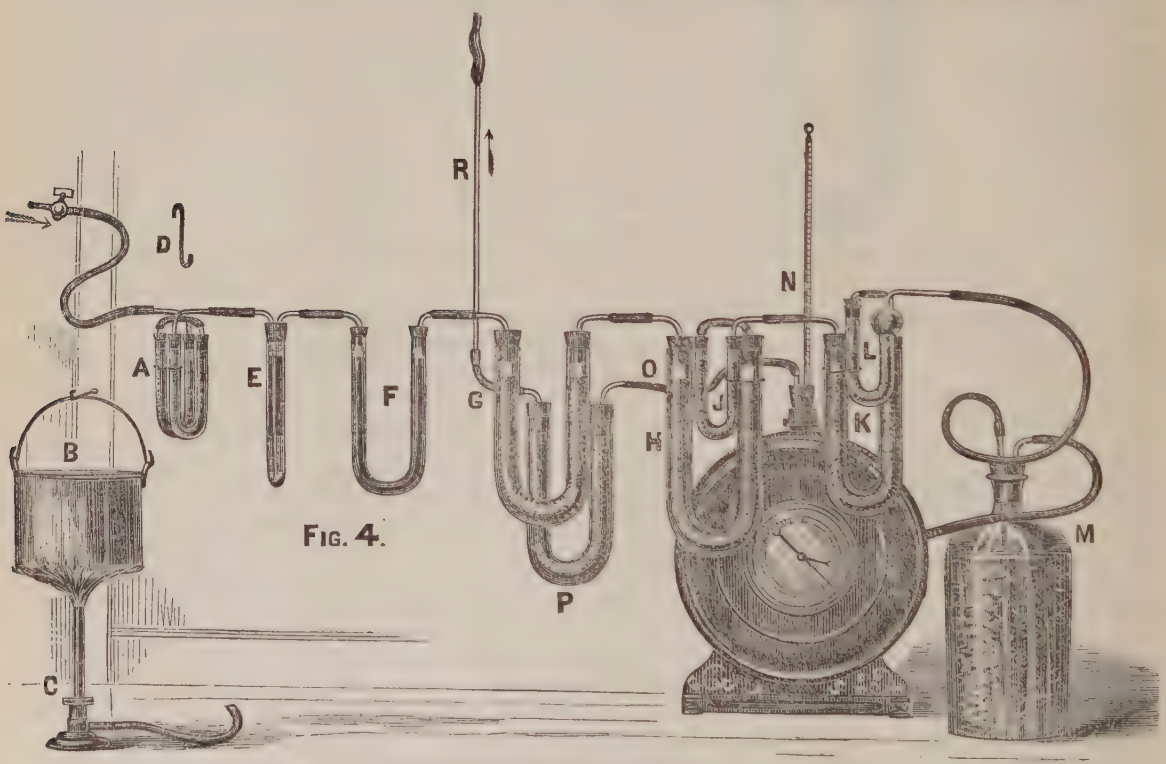


Fig. 4.

Train for the Analysis of Purified Coal-Gas, etc.

With reference to tube F, a remark should be made. The *hygrometric* equilibrium of the cupric sulphide, in the air and in the gas respectively, may appreciably vary, even at the same temperature. A safe plan, before initial weighing of this tube, will, therefore, be to pass through it a current of the gas to be analyzed, for a few minutes. This will also serve as a useful *qualitative* test of the amount of HS present.

When the HS is very minute, as it should be in a well-purified street-gas, there is another method available which I have used, and which may be preferred as surer. I find if the granulated blue vitriol be spread out in a sand-bath heat for a few days, it loses most of its water, turning white and chalk-like, without falling to pieces, and will now still absorb HS, even though the latter be absolutely dry. If F be charged with

such dehydrated cupric sulphate, it may be placed *after* the CaCl-tube G, instead of before, and will then absorb from the gas only HS. If it has lost three-fifths of *its water* it will not impart any water to the gas.* If the gas, however, is strongly sulphuretted, this plan will not do, as sufficient *sulphuric anhydride* is then set free to act appreciably on the hydrocarbons present, both absorbing them and forming SO_2.

After the whole train is put in action, during the actual analysis, should it be practicable to *watch* the apparatus during this stage, A may be *kept* immersed in the hot water in B, which will save subsequent expenditure of time in preparation for the final weighing. K must be watched from the first, and if it turns brown very rapidly—indicating *much* oxygen present—the current must be stopped when the meter has shown about one foot flow, and KL taken out to be weighed: resuming—after recording the meter—with a direct connection from J to M. This, because it may not be safe to trust K for more than one foot of gas *largely* contaminated with air.

The usual rate of flow advisable, if attainable with this train, is about one foot per hour, and the whole amount of gas analyzed should not be ordinarily more than 10 cubic feet. This does not necessarily apply to the NH_3 and HS determinations, however; as in a well-purified street-gas, the amount of these in 10 feet only might be scarcely appreciable. Therefore, after some 10 feet has passed the meter, the latter having been read and recorded, direct connection should be established from F to M, the intervening members being thrown out. The flow may then be kept on through A, E, F, M, the meter, and P, even up to 50 or 100 feet, or until the registered volume is judged sufficient for these two constituents.

Of course, in these cases the one-dial photometer meter will not answer, but a meter must be provided having dials enough to register continuously up to 100 feet, as well as down to decimals of a foot.

[In the absence of a sufficiency of *arrows* in this cut it will nevertheless, I trust, be understood that the course of the gas is from M to the inlet of the wet meter at its rear, and out again at its top, through the short rubber tube O to the final CaCl-tube P, and thence through the glass-tube R, from which it is represented as burning.]

In work with purified, unlike that with crude gas, no general distilling or transferring process is required before the final weighings. It is only essential that A should be free from condensed moisture at the close, by reason of immersion in B; or that it should be subsequently freed therefrom by means of a dry gas-current through and from the preparatory train.

V. Of the Dimensions of the Apparatus, etc.

The sizes and weights of the different pieces of apparatus must not be left unexplained.

Flask C is of one pint capacity. It is convenient to have at least four different sizes or patterns of U-tubes. The largest, represented by H in the preparatory train, is about 13 inches high, 1·1 inch internal calibre, and 2·25 inches between the limbs. The second size is the most useful size, the corresponding dimensions being about 8 × ·9 × 2 inches, and is exemplified in Fig 1 by F, G, H, L, M, and the omitted CaCl-tube; and in Fig. 4 by G, H, K, and P. The third size C and D in Fig. 2, and F in Fig. 4, may be 6·5 × ·6 × 1·9, and the smallest, represented in duplicate in A, and by J and L in Fig. 4, also by J and M in Fig. 1, is about 4 × ·4 × ·75.

The relative proportions of different members of a train to each other are worthy of careful consideration in planning an investigation, and much time and labor may often be thus saved. These proportions will differ with the conditions and with the nature of the gas very largely.

For convenience in weighing, wires may be attached, as has been shown in the cuts in one case only—the CaCl-tube GF in Fig. 2. As before stated, these wires, unless of platinum, are objectionable in the atmosphere of a gas-works, and the tubes can just as well be simply laid across the pan of the balance. The balance should be capable of bearing safely a load of at least 300 grammes or a little more, and indicating one milligramme; that is, of turning perceptibly with the 300,000th of its load.

One of the worst obstacles to accuracy in weighing large glass apparatus delicately being the well-known attraction of glass for moisture, I have adopted, as hinted before, a very valuble device; simply to provide thin polished brass or tin cases, closing tightly, but *not hermetically*, suited in size to different sizes of tubes; within which the latter are shut up while warm and dry.

VI. Of the Calculation of the Results.

To obtain from the observed volume, as per meter, the true initial volume of the mixed gas and spray operated on, requires some calculation. Taking first the most complex case, that of a crude coal gas from the hydraulic main, we shall have the following

FACTORS.		DENSITIES.*
The observed volume, in cubic feet and decimals;	which call *v*.	
The final Fahr. temperature of the gas;	which call *t*°.	
The weight of liquid tar, in grains;	which call *Lt*.	(Water=1)= 1·25
" " " water, in grains;	which call *Lw*.	
" " initial watery vapor;	which call *wv*.†	(Air=1)=0·6220
" " " gaseous ammonia (NH_3);	which call *am*.	" " =0·5896

* The densities adopted for NH_3, HS, and CO_2 are the theoretical ones employed by Bunsen in his *Gasometry*. Other authorities differ perceptibly about all these. The density of aqueous vapor adopted is very close to Regnault's figure. Bunsen used ·62205.

† It must not be forgotten that an addendum to *wv* is derivable from the final weighing of the bisulphate of potash tube.

* See *ante*; the experiment cited of Graham.

The weight of initial gaseous sulphuretted hydrogen; which call s ..... (Air=1)=1·1749
The weight of initial gaseous carbonic acid; which call c ..... " " =1·5202
The weight of initial naphthalene vapor; which call n ..... " " =4·5700

Other constants required in our calculation are:—

1. The coefficient of dilatation of coal-gas for the Fahrenheit degree. I adopt $\frac{1}{491·9}$.

2. The number of grains of pure water in a cubic foot, at 60° Fahr., which I make 436320.

3. The number of grains of dry air in a cubic foot, at 32° Fahr., equal to 565, according to Regnault.

As to the first, Ph. Jolly has recently given (*Chemisches Centralblatt* for 1874, p. 241; from Poggendorf's *Annalen*) new determinations, which for Fahr. degree are—

For H gas	·002031
" CO_2 "	·002059
" Air "	·002039*

As coal-gas is almost half hydrogen, I have adopted ·002033, which equals $\frac{1}{491·9}$.

For calculating the third constant, I have adopted as a basis a figure kindly calculated for me by Prof. A. M. Mayer,† directly from the original determination of Regnault, for a litre of dry air under normal tensions, equal 1·29278 gramme. Cooke's *Chemical Philosophy* gives this figure equal 1·29319 gramme.

From Mayer's figure I get closely enough, for one cubic foot of air at 32° Fahr., 565 grains.

In the most complex case of all, as in Fig. 4, when a wet meter is used, and the gas measured with a certain content of aqueous vapor, afterwards determined by means of the CaCl-tube P; we have, in this weight, still another factor, wv'.

The following crude expression may now be first jotted down; V being the corrected initial volume sought, in cubic feet, at 60° Fahr.:—

$$(A.)—V=v+\frac{60-t^\circ}{491·9}v+\frac{Lt}{436320\times\text{dens }Lt}+\frac{Lw}{436320}+\frac{wv}{565-\frac{(60-t^\circ)\,565\,\text{dens}\,wv}{491·9}}-\frac{wv'}{565-\frac{(60-t^\circ)\,565\,\text{dens}\,wv'}{491·9}}+\frac{1}{\frac{(491·9-60+t^\circ)\,565}{491·9}}\left(\frac{am}{\text{dens }am}+\frac{s}{\text{dens }s}+\frac{c}{\text{dens }c}+\frac{n}{\text{dens }n}\right).$$

Which, on interpolating the density figures above, may be reduced to—

$$(B.)—V=1·12198v-·002033t^\circ v+·000002292\left(\frac{Lt}{1·25}+Lw\right)+\frac{wv-wv'}{522·134+·71443t^\circ}+491·9\left(\frac{am}{143876·256+333·124t^\circ}+\frac{s}{286703·2+663·82t^\circ}+\frac{c}{370964·525+858·9t^\circ}+\frac{n}{1115187·4+2582.05t^\circ}\right).$$

In the case in which t° equals 28° F., as when the temperature is reduced quite down to that of melting ice, we may express it thus—

$$(C.)—V=1·065065v+·000002292\left(\frac{Lt}{1.25}+Lw\right)+\frac{wv-wv'}{542·14}+\frac{am}{311·45}+\frac{s}{620·65}+\frac{c}{803·06}+\frac{n}{2414·1}.$$

In the case of purified illuminating gas, as from street mains, in which the suspended tar and spray should be and ordinarily are inappreciable, the second right-hand member of the equation (C) disappears, as also the last factor representing the condensable naphthalene; and if, in addition, the gas has been measured dry, by means of a dry meter at the tail of the train, so as to eliminate wv', and also at 32° Fahr., we have (omitting an inappreciable fraction in the first factor) the simplest case of all—

$$(D.)—V=1·0651v+\frac{wv}{542·14}+\frac{am}{311·45}+\frac{s}{620·65}+\frac{c}{803·06}.$$

The correction for *atmospheric pressure* has not been introduced into these, and is independent thereof. In exact work, the barometer must, of course, be observed at short regular intervals, and V should be further corrected by reduction to the standard pressure of 30 inches or 762 mm. This is simple. Calling the volume as thus corrected V; and the mean of the barometric observations P. Then

$$V : V :: 30 \text{ inches} : P;$$

the volumes being inversely as the pressures; and—

$$V=\frac{P}{30}V;$$

from whence a rule, very easy to remember: Multiply the whole of the right hand side of the above equations by (·03333+)P.

Equation (D), corrected further for atmospheric pressure, may thus become—

$$(E.)—V=·0355Pv+·033333P\left(\frac{wv}{542·14}+\frac{am}{311·45}+\frac{s}{620·65}+\frac{c}{803·06}\right).$$

To the above discussion, it seems proper to append the remark, that the data determined by it, while necessary to the gas chemist, are not indispensably needed by the mere practical expert; who may be more concerned to refer the proportions of the constituents, as found, merely to the volume of *purified* gas, brought to, or near to, normal conditions of tension and moisture. This is a simpler affair. For the bottle of broken ice

* The figure of Regnault for this constant for air is almost the same as this; that of Magnus is a trifle lower. For Fahr. degree—
Regnault ·0020389, or $\frac{1}{490·46}$.
Magnus ·0020377, or $\frac{1}{490·75}$.

† Prof. Mayer remarks that he found a slight error in Regnault's own reduction of his observations.

in the above train, Fig. 4, I substitute, in this case, a similar one filled with *clippings of clean sponge saturated with water*, to serve the double purpose of bringing the gaseous current both to the temperature of the air, and to the maximum content of aqueous vapor correspondent thereto. If this be accurately enough accomplished, the direct reading of the meter, whether the latter be wet or dry, will be the required volume; subject only to the barometric correction above specified. The final CaCl-tube is then not needed, though it might still be used as a check upon the process, and will give a general and *precise* datum from which the gas may be calculated to any standard of temperature and moisture.

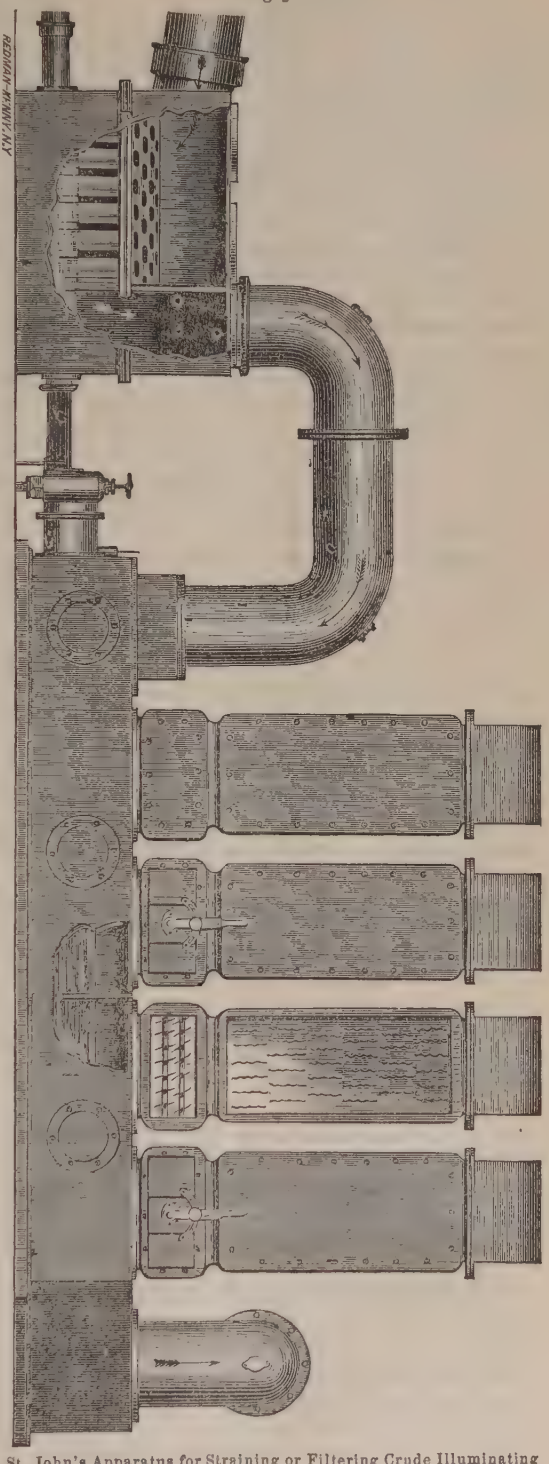
VII. An Example of Analyses made by one of these Methods.

I present, to exemplify the work done by one of these methods, some results obtained in testing a new American invention—or series of inventions—intended to accomplish the scrubbing of illuminating gas, without the external or internal application of water, and with the minimum of condensation by refrigeration.

The most important new principle used—an invention of Wm. H. St. John, of New York—is the forcing of the crude gas—*finely divided*—through the liquid products, aqueous and tarry, of its own incipient condensation. In the cut, Fig. 5,* which I am fortunate enough to be enabled to give, to illustrate this interesting invention, the main marked with an arrow on the extreme left is the inlet-port through which the crude gas is pumped from the hydraulic main—the pipe beneath it introducing also the liquids that flow from the latter.

After passing down the vertical tubes in the internal section shown on the left, the gas has to rise through a horizontal perforated diaphragm immersed in the condensed liquids. Two or more of these boxes (according to the exhausting power at command) are used in train; the gas then passing through the lattice-work "dry-scrubbers" on the right (also only partially shown). The figures quoted were obtained by attaching two analytical trains, after the plan of Fig. 1, one somewhat to the left of the position of the first arrow (in the extreme left of the cut), and the other to the outlet-port leading to the purifier, near the arrow on the extreme right. At the works of the Harlem Gas Light Company, where these analyses were made, there were two of the straining boxes in use, and the gas was passed at the rate of about 20,000 cubic feet per hour during the analysis. The reduced and corrected figures obtained were as follows (obtained from a volume of gas in each case of about seven feet, by the final measurement).

Fig 5.



St. John's Apparatus for Straining or Filtering Crude Illuminating Gases through Liquids.

* An electrotype cast from a cut borrowed from the *American Gas Light Journal*. Should its reproduction in this connection appear like "gratuitous advertising," I would claim that this is an exceptional case, being not a mere project, or a crude experiment, but an invention in successful use by a large gas company, and possessing exceptional novelty and merit.—H. W.

Weights: Grains per 100 cubic feet.	Crude gas, from hydraulic main.	Condensed gas, from inlet to purifiers.	Grs. taken out of each 100 feet, by scrubbers.	Percentage taken out, of each impurity.
1. Water	3515·2	2674·5	840·7	23·92
2. Tar	515·0	44·0	471·0	91·46
3. Smoke, soot, dust, etc	265·9*	55·7	210·2	79·05
4. Naphthalene (condensable)	123·5	25·0	98·5	79·77
5. Ammonia (NH_3)	339·4	237·0	102·4	30·18
6. Sulphuretted hydrogen	1234·9	1105·1	129·8	10·51
7. Carbonic acid	1698·0	1522·1	176·0	10·36
Totals	7691·9	5663·2	2028·7	26·39
Totals, without the water	4176·7	2988·8	1188·0	26·05
Average temperatures—Fahr.	107°·5	94°·6		
Volumes: Cubic ft. per hundred.				
Sulphuretted hydrogen	1·93	1·73	0·20	10·88
Carbonic acid	2·07	1·86	0·22	10·62

NOTE.—Dividing the above weights by 70 gives, closely enough, the lbs. of the impurities per *ton of coal.*

No. 12 HUDSON TERRACE, HOBOKEN, N. J.,
December 1, 1874.

SOLUBLE OXYCHLORIDES AND SULPHATES OF ZIRCONIUM.

BY H. ENDEMANN, PH.D.

About six years ago Mr. O. Loew and myself published some analyses of $ZrOCl_2$, which seemed to suggest to us, that the equivalent of zirconium was higher than it has been ascertained to be by other chemists, provided there be no other more basic soluble compounds in existence, which would tend to increase apparently the atomic weight. While indubitable facts compelled me to abandon the first idea, I have verified the latter by obtaining a series of compounds containing far less acid than the compounds hitherto described.

1. *Zirconium Oxybichloride,* $ZrOCl_2$.—This substance, which crystallizes quite easily, was first described by Hermann. If it be dissolved in water to be recrystallized, and the solution be evaporated, we find that not all of the solution can be obtained in crystals, and that a solution remains of the consistency of a solution of gum arabic, which on evaporation leaves a quite amorphous residue. This becomes more evident yet, if the dissolving and evaporation at low temperature, about 40° C., is frequently repeated. After repeating this five times, and analyzing the mass left, and calculating the equivalent, supposing that the composition of the salt were unaltered, I found the equivalent 94·72; or, in other words, I found that the salt thus obtained contained about $\frac{1}{18}$ more zirconia than the neutral, or, as I shall call it, oxybichloride.

The slowness of this operation was the reason that I abandoned it and substituted for it another method.

2. *Zirconium Oxyprotochloride.*—8 gms. of zirconium oxybichloride were dissolved in about 50 c. c. of alcohol, and to this solution about 200 c. c. of ether were added. An apparently crystalline precipitate was formed which was brought on a filter and washed with ether.

On examination it was found to be $\begin{matrix} ZrO\,Cl \\ ZrO\,Cl \end{matrix}\!\!>\!O$

1·854 gms. gave 0·3034 Cl.
and 1·042 ZrO_2

	Found per cent.	Calculated per cent.
Cl	16·365	16·366
ZrO_2	56 200	56·200

This substance is easily soluble in water, and was, when prepared as stated above and after drying in a desiccator, a white, very light powder.

3. *Zirconium Oxysubchloride.*—The zirconium oxyprotochloride, while easily soluble in water, is with difficulty soluble in alcohol. If this solution be again treated with ether, a gelatinous precipitate forms, which, when dried in a desiccator, has the appearance of aluminic hydrate dried at a low temperature. It is also perfectly soluble in water, and showed on examination the composition $8ZrO_2 + 7HCl$.

	Found.	Calculated.
Cl	15·18	15·20
ZrO_2	59·73	59·70

I do not know, that, without destroying the solubility of the compound, we might not by repeating the experiment arrive at a more simple formula by removing even more yet of the hydrochloric acid, but consider it at least possible.

Tin is accepted as one of the metals nearly related to zirconium, perhaps as near as titanium; we know that crystallized zirconia is isomorphous with cassiterite and rutile. The similarity, however, becomes more apparent by looking at the series of soluble oxychlorides which may be obtained from tin.

Weber's oxychloride of tin, obtained by dissolving

* With a little naphthalene, as since proved.

metastannic acid in muriatic acid, and allowing the solution to evaporate in a desiccator over lime and sulphuric acid, has the formula—

$$SnCl_4 + 3SnO_2 = \begin{matrix} SnO & Cl \\ SnO & O \\ & Cl. \end{matrix}$$

Burfoed's oxychloride was obtained by washing metastannic acid with muriatic acid, filtering, and freeing the residue from adhering free muriatic acid by pressing between filter paper. This substance dissolves in water, and on examination contained—

$$9SnO_2 + 8HCl.$$

$9ZrO_2 + 8HCl$ would require—

Cl	15·40
ZrO_2	59·51.

4. *Sulphates.*—$Zr2SO_4$ and ZrO,SO_4 were prepared by Berzelius. They are both decomposed by water, the latter especially on heating, when a basic insoluble precipitate is formed.

I endeavored at first to precipitate the salts from the water solution by means of alcohol. While commencing with the acid salt, first mixtures were obtained of acid and neutral salt; but the composition of the salts, after repeating the same operation, soon became decidedly basic, as is shown by the following figures, where the zirconium is calculated to one equivalent of acid, viz., 92·08, 92·80, 93·12, 94·30, 96·44, 96·58, 96·78, 97·00, 99·14, and finally 110·06.

All these salts are soluble in a small quantity of water, but are precipitated by an excess of cold water, an insoluble basic salt, and an acid salt remaining in solution, being the result of this reaction.

The result of this decomposition varies according to the amount of water taken, and according to the composition of the salt undergoing decomposition.

One salt with 400 pts. of water gave a precipitate containing its constituents in the proportion of 3 equivalents of acid to 5 equivalents of earth.

	Found.	Calculated.
$3SO_3$	79·86	79·86
$5ZrO_2$	202·1	202·54

The solution contained ·018 $ZrO_2 \times 0·1312$ SO_3, or for 1 equivalent of ZrO_2 more than 11 equivalents SO_3. Another soluble basic sulphate decomposed with 400 pts. of water gave a precipitate which, on examination, gave the following results, 1·685 gms. gave—

0·3323 SO_3 = 19·72 per cent.
0·925 ZrO_2 = 54·70 " "
HO = 25·58 " "

or about $11ZrO_2, 6SO_3, 34H_2O$.

Though it is not possible to obtain a precipitate of always the same composition, this reaction may well be used for the purpose of freeing zirconia from certain impurities.

The salt which contains 110·06 zirconium to 1 equivalent of acid is the last one which I have obtained, and is composed of—

$6SO_3$ to $7ZrO_2$.

	Found.	Calculated.
ZrO_2	54·415	54·36
SO_3	30·59	30·65

This may, however, be not the final result, for the salt, being thus obtained, may yet be a mixture of neutral salt, and a still more basic soluble sulphate.

I will mention here that the precipitate, after drying, is obtained as a white inodorous powder; which, however, contains organic substance in the shape of alcohol, substituting water of crystallization. Moistening with water, and subsequent evaporation in the water-bath, remove this easily. The salt is then obtained as a mass resembling gum arabic, and is perfectly free from organic substance, if the alcohol and ether used in the preparation were pure. Alcohol and ether, therefore, ought to be thoroughly freed from impurities, especially acids, which are often contained in alcohol, since these basic salts exhibit great affinity for them.

It is but natural to suppose that this tendency to form soluble basic salts is not confined to the two acids mentioned. At the same time I believe that this peculiarity gives an easy explanation for Svanberg's publications, who first announced norium, an element which he obtained from the mother liquor of crystals of zirconium salts, and which had, according to him, a higher equivalent than zirconium, and who, later again, suspected the presence of a number of earths, the equivalents of which ranged from 90 upward.

The zirconia used for this examination was thoroughly examined for and freed from impurities, and also its identity established by its reactions.

AN ESSAY ON AMERICAN CONTRIBUTIONS TO CHEMISTRY.

Read at the Centennial of Chemistry at Northumberland, Penna.

BY PROF. BENJAMIN SILLIMAN.

(Continued from page 209.)

Henry Wurtz (Addenda).

1864. Report made to and published by the Manhattan Gas-Light Company; on the History and Value of Water-Gas Processes.

1866. A Theory of Gold-Genesis, read in abstract to the Buffalo meeting of the American Association, in 1866. Published in the *Am. Journal of Mining*, of Jan. 25, 1868, page 50, and following issues.

In this paper was first presented the true theory of the origin of the heat of metamorphism, as now recognized by Dana, Sterry Hunt, and other leaders of science.

1868. Report to the Manhattan Gas-Light Company, on the relative merits of the Lime and Iron Methods of Purifying Gas.

Republished at the time in the *London Journal of Gas-Lighting;* also more recently in the *American Gas-Light Journal*, vol. xxi. pp. 65 and 83. (Contained the first statement of the principle of the absorption of CS_2 by the sulphide of calcium in a fouled lime-purifier; since covered by a patent taken out by R. H. Patterson.)

1868. On a Suspected New Element in the Magnetites of the Laurentian Rocks. *Am. Journal of Mining.* (The reference I have not been able to get. H. W.)

1869. Argument against Hydrogenium. *Am. Gas-Light Journal*, July 16, 1869, p. 18.

1869. The Grahamite of West Virginia and of Colorado. Read to the Salem meeting of the American Association, in August, 1869. Published in full in the *Am. Gas-Light Journal*, of October 2, 1869, p. 98.

1869. Water-Gas Researches; in conjunction with Professor Silliman; involving the investigation of the continuous manufacture of water-gas from incandescent steam and anthracite coal, in a bench of clay retorts, throughout a period of five months. A small edition published in book form, in the spring of 1869. Republished in the *Am. Gas-Light Journal*, commencing with the issue of Jan. 16, 1874, p. 21; also in the *London Journal of Gas-Lighting*, commencing with Oct. 20, 1874, and running through many issues.

1870. A New Theory of Coal-Genesis; read Jan. 10, 1870, to the New York Lyceum of Natural History. *Am. Gas-Light Journal*, Jan. 17, 1870, p. 18. A product of a special eremacansis in waters containing iron sulphate and free carbonic acid, and with congenesis of ferrous carbonate, hydrate, and sulphide.

1870. Discussion with Prof. Sterry Hunt, on points in Chemical Geogony. *Am. Gas-Light Journal*, Feb. 2, 1870, p. 35.

1870. Reclamations for Doebereiner against Frankland, in reference to luminiferous combustion of hydrogen under pressure. *Am. Gas-Light Journal*, August 16, 1870, p. 51.

1870. On the Chemical Geogony of Silica. Read to New York Lyceum of Natural History, Oct. 10, 1870. Proceedings for 1870, p. 56; also (in far more complete form), in *Am. Gas-Light Journal* for Nov. 2, 1870, p. 130. (See, also, the latter journal for Sept. 2, 1870, p. 67; and for Oct. 16, 1872, pp. 130 and 134.)

Theory that all free Silica in Nature is due to Organic Life.

1870. The Structure and Lithology of the Hudson River Palisades. Read to the New York Lyceum of Natural History, Nov. 14, 1870. Proceedings for that year, page 99. See, also, Proceedings for March 13, 1871, pp. 196 and 244. Metamorphic character of the Palisades demonstrated; also the feldspathic psammitic character of the inclosing so-called "sandstones," and the micaceous constitution of the so-called "shales." The so-called "diorite" trap is hyperite, composed of hypersthene prisms in a labradorite paste. In the granular psammite the feldspar is albite, derived by alteration from sodic oligoclaze from the Highlands on the northwest.

1871. Analysis of a New Jersey Greensand Marl, containing 10·41 per cent. of Ferrous Carbonate. New York Lyceum of Natural History. Proceedings for 1871, p. 239.

1871. Gas-Wells: Historical, Geological, Chemical, and Engineering Discussions. Read to the New York Society of Practical Engineering, Nov. 15, 1871; also to the New York Lyceum of Natural History, Oct. 2, 1871. Proceedings of Lyceum for 1871, p. 260; much more fully in *Am. Gas-Light Journal* for Dec. 2, 1871, p. 162. The theory presented of the chemi-genesis of the marsh-gas of these wells was that it naturally forms the final residue of the abstraction of carbon from organic matter, by a powerful oxidizing agent, this agent being oxygen conveyed by ferric solutions. The author connected it, therefore, with his previously announced theory of coal-genesis.

1874. On the Subaerial Oxygenation of Waters. New York Lyceum of Natural History. Proceedings for Feb. 16, 1874, p. 103. New microchemical method of oxymetry in aqueous liquids by means of pyrogallol. Discovery that CO_2 completely expels oxygen from solution. Method of determination of rate of subaerial oxygenation.

1874. Analytical Examination of the so-called "Mineral Coke" or "Carbonite," from the Richmond Coal-Basin; showing it to be a semi-bituminous variety of coal, giving off oily products on distillation, heretofore probably mistaken for water. Has 14 per cent. of volatile matter. *Am. Gas-Light Journal*, Feb. 2, 1874, p. 44.

1874. Lignite from Disco Island, Greenland. Has the highest density recorded, = 1·46. *Proceedings of N. Y. Lyceum of Natural History*, March 9, 1874, p. 119.

Thomas M. Drown, Ph.D., Professor of Chemistry, Lafayette College, Easton, Pa.—Dr. Drown, besides several important papers on the Blast Furnace, Puddling Process, Bessemer Process, etc., has contributed the following which are more especially chemical:—

1864. "Separation of Cerium from Lanthanum and Didymium" (contributions to chemistry from Lawrence Scientific School from Dr. Gibbs). *Am. Jour. Sci.* [2], xxxvi. 324. 1864.

1874. "Estimation of Sulphur in Pig Iron and Steel." *Transactions of Am. Inst. of Mining Engineers*, Philadelphia.

1874. Conditions of Carbon in Gray and White Pig Iron. Ibid.

Charles Upham Shepard, Jr., M.D., Charleston, S. C.—The so-called "Reduced" Phosphate and the Valuation of Old Commercial Fertilizers. *Rural Carolinian*, June, 1872.

Some Foreign Phosphatic Deposits. *Rural Carolinian*. Jan. 1873.

On Soils. *Rural Carolinian*, Sept., Oct., and Dec. 1872; March, April, May, June, 1873.

Toxicological Effects of Sulphurous Acid Gas on Vegetation. *Transactions of South Carolina Medical Association*, 1873.

Various papers on the marls, phosphatic rocks, and mineral waters of South Carolina. *Rural Carolinian* and other journals.

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On the Behaviour of Benzoic Acid in the Organism of Fowls. (Ueber das Verhalten der Benzoisaure im Organismus der Hühner.) Inaugural Dissertation. Göttingen, 1867. *Zeitschrift für rat. Med.* Bd. xxxi.

On the Occurrence and Composition of the Nodular Phosphates of South Carolina. *Amer. Journal of Science and Arts*, May, 1869.

(To be continued.)

DIRECT COMBINATION OF CHROMIC ACID WITH WOOL AND SILK, AND ITS APPLICATION TO THE ANALYSIS OF WINES AND TO DYEING.

BY M. E. JACQUEMIN.

Translated by Josephine Chevalier.

Until now free chromic acid has been considered merely as a mineral coloring matter, this character be-

longing only to lead chromate, which fixes itself on vegetable and animal fibres by double decomposition.

Chromic acid in combination with potassium, potassium bichromate, is frequently employed for dyeing blacks with the aid of Campeachy logwood, the hæmatoxylin of which is oxidized at the expense of the mineral acid; thus it serves as a modifier of colors, in impressing the tissues for red, rose, puce *de Saint Marthe*, with addition of the acetate of aluminium in the first two cases, and of the mordant of aluminium and iron in the third. The same potassium bichromate furnishes by conversion catechu-browns of remarkable beauty and solidity, etc. etc.

It would seem that the circle of applications of chromic acid might be susceptible of widening, from these experiments. Notwithstanding the very energetic oxidizing power of this body, it was found to unite directly with silk and wool, and to produce with fibres of animal origin, without altering them, a yellow combination which resisted washing and soaping; and which appeared of such a nature as to be utilized in the industry of dyeing.

To obtain pure yellows on white wools, they were passed into a bath of about 60 degrees, containing the fifth of the weight of the wool of sodium carbonate, so as to remove the last traces of sulphurous acid; then, after washing and while tepid, were put into a bath of chromic acid composed per kilogramme of material as follows:—

Potassium bichromate	60 grms.
Sulphuric acid at 66 degrees . .	60 "
Water	from 40 to 50 litres.

A few minutes at 30° are sufficient to obtain a straw color of a very beautiful shade, the skeins being turned and maintained during 20 minutes at a temperature which it is not necessary to elevate to more than 60°. After which they are washed freely with water.

The bath with the above proportions is not exhausted; there remains in solution a sixth of chromic acid. The quantities could therefore be reduced, but then more time would be necessary to remove completely the coloring matter.

In the author's experiments, 2 grammes of wool entirely removed or withdrew the chromic acid produced by 0·1027 potassium bichromate treated with 0·098 sulphuric acid, leaving a colorless liquid in which could hardly be detected any traces of chromic sulphate.

If this new yellow presents the degree of solidity required, which cannot as yet be positively asserted, no doubt dyers will enter this process in the practice of their art, for it joins to the extreme facility of its application, an indispensable quality, cheapness, since the net cost of the first material of the dyeing bath does not exceed 25 *centimes* per kilogramme of wool.

It is easy to recognize that the yellow color fixed on the tissues is due to chromic acid and not to lead chromate, nor to an organic yellow, for by incineration we obtain a green skeleton of chromic oxide, which, when melted with nitre, gives a limpid solution of potassium chromate. Cotton is not dyed under the same circumstances. Also, the passage of woollen or silk tissue through tepid chromic acid, after washing, would allow the fibres of vegetable origin, which were made to enter into materials of inferior price, to be visible.

Chromic acid combined with wool retains some of its characteristic properties; it unites in the cold with the oxide of lead of the subacetate, without leaving the animal fibre, forming a clear yellow chromate, the shade of which differs from chromic yellow; it is reduced by sulphurous acid to a state of chromic oxide, which the wool retains while the sulphuric acid remains in the solution. The animal fibre can be sufficiently charged with chromic oxide, so as to obtain solid greens, by passing it in succession through a tepid chromic acid bath, then through a weak solution of sulphurous acid, until the height of color required is reached. A consequence is brought forward by this fact; since chromic acid fixed on wool, has not lost its oxidizing power, it ought to modify certain dyeing baths, by oxidizing the coloring materials, and becoming itself chromic oxide, combining and engendering shades, some of which might find favor with dyers.

There are, without doubt, exceptions to this rule. Thus chromic wool does not act on the cochineal bath, it absorbs aniline colors without modifying them, and without the superposing of the red or blue over the yellow appearing to produce for the deep colors a shade sensibly diminished. When wool dyed with chromic acid is passed into a bath of fustic wood and boiled, there is obtained a solid reseda color. Plunged in a fustet bath, it furnishes the color designated by the name of *bismark*. With madder it gives a particular color, which is neither garnet nor catechu, but an intermediate color which cannot be better designated than by the expression garnet-catechu. Canary color is directly fixed on the combination of wool with chromic acid, but the canary shade seems to be somewhat diminished. Logwood gave a brown color in lieu of black, as was expected; it is that which makes it hold, that the small quantity of chromic acid fixed on the animal fibre is incapable of modifying a sufficient proportion of hæmatoxylin.

A mixture of logwood and brazil produces iron-gray colors, which approach very nearly to black, but which contain too much blue; by varying the proportions, black would certainly be obtained. By adding elsewhere fustet to the preceding dyeing bath, blacks superior to the ordinary campeachy blacks were obtained; they were obtained more clear and without redness.

Dyers may perhaps find some advantage in applying this process for certain shades: reseda, bismark, garnet-catechu, black, etc., since it avoids the usual prolonged process of dyeing with mordants, where the simultaneous introduction of the mordant and coloring matter, frequently causes partial precipitation of the latter. The application might be attempted for the impression of tissues. It would suffice to pass the woollen or silk tissue into chromic acid, and imprint on this foundation the thick colors spoken of above, which would be fixed by evaporation. The properties of wool dyed in chromic acid, very naturally led the author to apply them to researches on the colors which serve to falsify wines.

The ascertaining of the coloring matter which transforms a white alcoholic wine into a red wine does not, generally, presents difficulties by ordinary chemical reactions.

But it is altogether a different thing, when it is the question of a natural red alcoholic wine of the South, which has been diluted with water, colored in so many ways. The natural color masks the reaction of the *corpus-delicti*, or interferes with its clearness. Now, wool dyed with chromic acid, and passed through the natural wine, takes after prolonged ebullition a characteristic clear brown color, always the same, whatever may be the source of the wine. Then it can be easily seen that such wool passed through a mixture of natural wine and strongly colored water takes, if the coloring added is influenced by chromic acid, a dye which, though

diminished in intensity by the fixing of the natural pigment, will allow no hesitation on the nature of the fraud. Some coloring matters are not fixed by the intervening of chromic acid, cochineal for instance, but this method is nevertheless applicable to such cases, as the author hopes to demonstrate in an early note, since it suffices to substitute an appropriate mordant in place of chromic acid. It was by this method that the author convinced himself that mordants to-day replace the heavy wines of the South, dyed with cochineal, which at 12 francs per kilogramme, allows them to give the color of wine to a greater number of hectolitres of water: thus he also ascertained that red caramels for new and old wines, which are sold in Paris, owe their coloring power to aniline derivatives.

ON COCOA AND ITS MANUFACTURE.

BY JOHN HOLM, F.R.C.S. EDIN.

The subject, the consideration of which will occupy our attention this evening, and which I have the honor of bringing before you—namely, "Cocoa and its Manufacture"—is one of considerable importance, treating as it does of one of the most valuable foods which man derives from the vegetable kingdom.

The cacao or chocolate tree, which yields the cacao—cocoa—or chocolate-nut, belongs to the natural order *byttneriaceæ*. Linnæus bestowed on it the name *Theobroma*, derived from the Greek words Θεὸς (God) and Βρῶμα (food); and is stated to have been given to the plant in consequence of that great botanist's delight in the food-drink prepared from its seeds, in which it is stated he largely indulged and somewhat ideally regarded as "food fit for the gods." Of the species *theobroma*, there are nine individuals mentioned by botanists, of which the *Theobroma cacao* is the most important, and yields the best and finest fruit.

Varieties of the Cacao Tree.

Name.	Country.
Theobroma Cacao (Sativa) (Linnæus)	West India Islands.
Theobroma ovalifolium (De Candolle)	Mexico (Soconuzco).
Theobroma angustifolium (De Candolle)	Mexico.
Theobroma Guyanense (Aublet)	Guiana.
Theobroma bicolor (Humboldt)	Brazil and New Granada.
Theobroma speciosum (Wildenow)	Brazil (Para).
Theobroma sylvestre (Martius)	Brazil and Jamaica.
Theobroma microcarpum (Martius)	South America (wild species).
Theobroma glaucum (Kusten)	

The cacao tree is indigenous to tropical America, and is there found in its wild state. The range of latitude in which it grows may be placed as between the seventeenth parallels, in which area it flourishes best; its cultivation has, however, been extended with success as far as the twenty-fifth parallel; its range of altitude extends from a few feet to 1760 feet above the level of the sea. Mexico appears to be the original home of this tree, from whence it gradually extended into South America and the West India Islands. At the time of the discovery of Mexico by the Spaniards, it was almost the only plant in the cultivation of which care was taken; it was grown in large quantities, and great pains were bestowed upon it, it being regarded by the natives as the most valuable product of their country. The tree was called by the Mexicans "Cacava quahuitl," and also "chocolalt;" while the preparation made from its seeds was named "chocolatl," a name said to be derived from the noise made by crushing the bean between two stones. It is from this native nomenclature that we derive the words cacao and chocolate, the former of which has been corrupted into the better-known word cocoa, applied generally both to the seeds of the plant and the preparation derived from them.

The cacao tree is an evergreen of very beautiful appearance, and has been likened in height and form to the cherry tree. It is taller in its wild than in its cultivated condition, in which the height is curtailed. The height of the adult trees ranges from fifteen to forty feet. The wood is porous and light, but capable of taking a high polish. The bark is of a cinnamon color, becoming deeper as the age of the tree advances. The foliage is profuse, the leaves being of a green color, varying in shade according to the species and nature of soil. They are smooth and glossy, lanceolate in form, with plain edges. In size they vary from 7 to 10 inches in length, and from 2½ to 3½ inches in breadth, growing principally at the top of the tree. The flowers are very plentiful; they are small and clustered, and spring directly from the larger branches and the trunk itself, and according to Humboldt, even from the roots of the tree if these are left uncovered. They are of a saffron and sometimes a pink color, and are devoid of scent. The buds are similar to cherry stones in size and form, and of a whitish-pink or green color. Large numbers of the flowers fall before attaining maturity, and thus the yield of the fruit is greatly less than the number of the blossoms put forth; not more than one pod being usually produced from each cluster of flowers.

The leaf and flower of the cocoa nut with the pod open.

The cacao fruit, or pod, is of an elliptical ovoid shape, and pointed at the end; it varies considerably in form in the different species, and measures from 7 to 10 inches in length, and 3 to 4½ inches in breadth. The surface is somewhat rough, with deep longitudinal furrows. In color the surface is green, but as it ripens it becomes of a bluish-red color, gradually deepening to a decided purple; or else, in certain varieties, it becomes of a deli-

cate yellow or lemon color. The rind of the seed pod is about half an inch thick, is tough, and requires some force to break it. The pod is divided into five compartments, in each of which is ranged a row of five to ten seeds, lying in a gelatinous pulp. A single pod thus yields from twenty to forty seeds. It is these seeds which form the raw cacao, or cocoa of commerce, from which the various preparations of manufactured cocoa and chocolate are made. I shall now pass on to give a brief description of the general mode adopted in the cultivation of this valuable plant, merely premising that slight differences of method obtain in different countries and districts.

In the selections of ground on which to form a cacao plantation, it is necessary to choose a spot in which the soil is rich and loose to a considerable depth. It should also be near a stream, so that efficient means of irrigation may be insured. The tree is found to flourish best on hilly slopes which face away from the quarter whence the cold winds which prevail may blow. The young plants should be reared in nursery grounds, where the seeds are sown in small mounds placed at short distances from each other. In each of these two seeds are placed, but when both germinate it is usual to destroy the weaker of the two plants. In ten or twelve weeks these should have attained a height of fifteen to eighteen inches, and are then fit for removal to the plantation. The ground has here been previously prepared, and as the cocoa tree requires protection from both the sun and wind, banana and coral-bean trees, the latter called "madre di cacao," are planted at intervals between the spaces allotted for the cocoa trees, which are placed in rows at regular intervals, varying according to the nature of the soil, from fifteen to thirty feet. When the tree has attained the age of two years, it puts forth several branches, and the flowers now shortly begin to appear, but are removed that the strength of the tree may not be impaired. About the fifth year the tree is very rich in foliage and strong enough to bear, and the blossoms are now allowed to mature. It is not, however, until the eighth or tenth year that it yields a plentiful crop. It then continues prolific for thirty or forty years.

One of the peculiarities of this tree is that the leaves, flowers, and unripe and mature fruit may be seen growing plentifully at one and the same time. The fruit therefore has to be gathered when ripe throughout the year, but there are two periods at which the produce is most plentiful; these are the months of June and December, which are regarded as the harvest months of the cocoa plantations.

In gathering the cocoa crop the workman whose duty it is to select the pods (this requires great care and experience) is armed with a long, wooden fork, with which he disengages the fruit from the tree. He is followed by others, who collect the fruit into heaps and carry it into sheds, where the pods are opened and the seeds taken out. Each tree will yield from one pound and a quarter to eleven pounds per annum. The seeds have now to undergo a peculiar process, called "curing," before they are fit for use by the manufacturer. This process is one of great delicacy, and requires much experience and skill to conduct it successfully. Upon it depends in a very great degree not merely the preservation of the cocoa, but the development in it of a fine flavor. There are two modes of conducting it. The simpler one is merely to place the cocoa seeds, when taken from the pods, in heaps in the sun, and these are stirred at intervals. A sufficient quantity of the pulp in which the seeds are imbedded adheres to them to supply enough moisture to give rise to a moderate amount of fermentation, which ceases when the nuts are sufficiently dry to be packed. The other mode is by "claying," that is, the nuts are placed in holes or trenches dug in the ground, and covered with clay or sand; they are stirred at intervals, and great care is taken to prevent the fermentation which arises from proceeding too violently. When it has reached its proper point, the nuts are spread upon a platform or upon mats until perfectly free from moisture, when they are placed in bags.

The use of cocoa as a food by the Mexicans, at the time of the discovery of that country by the Spaniards, is the first knowledge we have of it. With them it was esteemed the most valued product of the country, and Prescott informs us the Emperor Montezuma took no other beverage. The seeds were also used as coins, a fixed value being attached to them, and this custom Humboldt tells us was in existence in his time. The Spaniards did not at first appreciate the virtues of chocolate, and one of their earlier travellers describes it as a "drink fitter for a pig than a man;" but this feeling speedily changed, and their love of this beverage became almost a passion.

The method of the Indians was followed by the Spaniards, whose process is thus described by Simmonds:—

"The kernels are roasted in an iron pot pierced with holes; they are then pounded in a mortar, and afterwards ground between two stones, generally of marble, till they are brought to a paste, to which sugar is added, according to the taste of the manufacturer. From time to time, as the paste assumes consistency, they add long pepper, arnatto, and lastly vanilla. Some manufacturers vary these ingredients, and substitute cinnamon, cloves, aniseed, and sometimes musk and ambergris."

The introduction of cocoa into Europe may be placed at 1520, when Columbus brought home samples of the nut. Spain, however, for some time depended on the colonies for the manufactured article, but when the art of preparing it was conveyed there, the raw material was also imported. The Spaniards, by jealously guarding as a secret the mode of manufacture, were able to retain the monopoly of all trade in chocolate for many years.

The value of chocolate was speedily appreciated by the physicians of Europe, and Hoffmann wrote a monograph treating of it, entitled "Potus Chocolati" in which he recommends it in many diseases, and instances the case of Cardinal Richelieu, who, he states, was cured of general atrophy by its use.

It was probably more than a century after the introduction of cocoa into Europe before the English became acquainted with it. According to my late partner, Mr. Hewett, the earliest mention of its use appears in a newspaper called Needham's *Mercurius Politicus*, dated the 16th of June, 1659. For many years England continued to import all the chocolate she consumed in its manufactured state; but I believe about the commencement of last century several persons commenced the manufacture in this country. There is very strong reason to believe that a knowledge of the mode of preparation was brought into England by Sir Hans (then Dr.) Sloane.

Before considering the modes of manufacture which have been adopted in this country, it will be convenient to notice the characters and chemical composition of the cocoa beans. In shape these are something like

an almond, but rather thicker; they vary both in size, shape, and quality, the various growths having distinct characteristics. Our principal supplies are drawn from Trinidad and the Spanish Main, which yield the best qualities; and from Ecuador and Peru, the Island of Grenada, and Guiana. The following is a list of the cocoa growing countries:—

Country.	Commercial name of growth.
Trinidad	Trinidad.
Mexico	Soconuzco.
Spanish Main:—	
New Granada	Magdalena.
Venezuela	Maracaybo. / Caraccas.
Guatemala	Central American.
Ecuador, Peru	Guayaquil.
Grenada (Island of)	Grenada.
Guiana	Surinam. / Berbice.
Cuba, Guadeloupe, Martinique, St. Croix, St. Lucia	The name of each island.
Dominica, St. Vincent, Jamaica	The name of each island.
Brazil	Para. / Maranham. / Bahia.
Guinea (Western Africa)	African.
Bourbon, Philippines, Mauritius, Madagascar, Australia	The name of country; yield quite unimportant.

I would now recall to your minds the manner in which the cocoa nuts or seeds are contained in the cocoa pod. If we examine the seed as imported, we find that it is enveloped in a husk or shell of its own. When this is removed, the surface of the nut is seen to be marked by slight grooves, which divide it into irregular portions. These depressions mark the position of a fine membrane, which penetrates into the substance of the seed and divides the two cotyledons from each other, and also each of these into several lobes. It is these irregular segments of the cotyledons which, when broken down, form cocoa nibs.

The chemical composition of cocoa is shown in the table before you, which gives the different analyses of any importance which have been made:—

Analyses of Cocoa.

	Lampedius.	Tuchen.	Payen.	Johnson.	Playfair and Lankester.	Miller.	Bonssingault.	Mitscherlich.		Muter.	Average of several other analyses.
Fat (Cocoa Butter)	53·10	36·97	52·00	51·00	50·00	56·00	44·00	45·00	49·00	42·67	50·00
Albuminoid Substances	18·70	...		...	...	17·00	...	13·00	18·00	...	...
Albumin	...	...	20·00	...	20·00	...	20·00	...	...	...	18·00
Fibrin	...	...		...	...	...	...	...	...	...	
Gluten	...	30·20	...	20·00	...	...	...	...	...	12·21	...
Extractive Matter	...	4·14	...	...	...	...	...	...	...	...	...
Sugar	...	...	...	...	...	...	...	0·60	...	...	...
Starch	10·91	0·55	10·00	22·00	7·00		...	14·00	18·00	19·03	10·00
Gum	7·75	0·69	...		6·00		6·00	...	...	6·40	8·00
Lignine	0·90	...	...	...	...	22·00		...	...	...	...
Cellulose	...	30·00	2·00	...	...		13·00	6·08	...	5·95	...
Woody Fibre	...	...	...	...	4·00		...	...	...	...	...
Coloring Matter	2·01	6·61	traces	...	2·00	...	...	3·05	5·00	3·96	2·60
Water	5·20	6·01	10·00	5·00	5·00	...	11·00	5·06	6·30	5·98	6·00
Theobromine	...	0·56	2·00	2·00	2·00	1·50	2·00	1·02	1·50	0·90	1·50
Salts	...	3·00	4·00	...	4·00	...	4·00	...	...	...	...
Ash	...	...	...	...	...	...	...	3·05	...	2·90	3·60
Humic Acid	...	7·25	...	...	...	...	...	...	...	...	...
Parts unaccounted for	1·43	1·02	...	...	...	3·50	...	9·14	...	...	0·30
Total	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	...	100·00	100·00

It is a table which is not very flattering to chemical science, the analyses being of the most contradictory character, and containing discrepancies which cannot be at all reconciled with each other. I should judge that the analysis prepared by Drs. Playfair and Lankester is the most correct, while those of Tuchen and Muter appear least so. We thus see that, taking the important constituents, cocoa contains:—

	Parts.
Cocoa butter	50
Albuminoid substances	20
Starch, sugar, etc.	13
Salts	4
Theobromine	2
Other constituents	11
	100

Taking these in the order of their importance, we first notice the fat, or cocoa-butter, which forms about half the substance of the nibs. It is a hard, fatty substance which, when clarified, is of a dead white color. Its melting point is about 100° Fah., which being the heat of the body renders it of great value for therapeutical purposes. The fat never becomes rancid, however long it may be kept, a quality peculiar to itself. It is hardly necessary to point out how valuable this quality renders this portion of the bean, for it places cocoa-butter first in the list of the fatty class of our carbonaceous or heat-giving foods. The albuminoid constituents form about 20 per cent. of the nib. These are classed amongst the nitrogenous principles of food, and their presence renders cocoa one of the richest flesh-formers we have. The starch, gum, and sugar present, like the cocoa-butter, belong to the non-azotized principles; they form about 13 per cent. of the whole. The alkaloid of cocoa, *theobromine*, is very similar in its physiological effects to its analogues, *theine* and *caffeine*, from which it differs very slightly in chemical composition.

Essential Alkaloid Principles.

Yielded by	Name.	Composition.	Proportion.
Cocoa.....	Theobromine	$C_7 H_8 N_4 O_2$	2 per cent.
Coffee	Caffeine		
Tea.....	Théine	All identical $C_8 H_{10} N_4 O_2$	1 to 5 per cent.
Guarana ..	Guaranine		
Maté.....	..		In less quantities.

In regard to these alkaloids, it is interesting to note that throughout the world the instinct of man has led him to seek some substance which contains one of these principles, which owe their value to the specific influence they exert on the nervous system, stimulating it and checking waste of tissue. *Theobromine*, when extracted, presents the form of a white crystalline powder of almost amorphous appearance, differing from *caffeine* and *theine*, which have a very beautiful crystalline appearance.

In most of the analyses of cocoa the existence of a volatile oil has been overlooked. It is probably present only in small quantities, and appears to be developed by roasting; but upon it depends the flavor and aroma which exist in cocoa.

Having thus noticed the principal component parts of cocoa, a comparision with other foods, as given in the following table, will be of interest as showing its relative value to them.

Table Showing the Relative Compositions of

	Cocoa.	Milk.	Meat (Beef).	Wheaten flour.
Fat	50·0	3·5	2·87	1·2
Azotized substances	20·0	4·0	20·75	14·6
Starch	7·0	..	..	59·7
Gum	6·0	..	..	..
Sugar	..	4·3	..	7·2
Water	5·0	87·5	67·80	13·2
Salts	4·0	0·7	5·60	1·6
Woody fibre	4·0	..	..	..
Cellulose	..	..	..	1·7
Coloring matter	2·0	..	..	..
Ash	..	..	1·60	0·8
Extractive matters	..	..	1·38	..
Theobromine	2·0	..	..	..
Parts	100·0	100·0	100·00	100·0

By this it is apparent that in nutritive power cocoa holds an entirely exceptional position. It combines in a high degree of concentration nearly all the elements necessary to man's existence. It is deficient in moisture, which renders it comparatively richer in both nitrogenous and non-nitrogenous elements than any of those with which it is compared. Thus, although one-half of its weight consists of cocoa-butter, it still presents 20 per cent. of albuminoid material, as against 4 per cent. in milk, 20·75 in beef, and 14·6 in wheat. In addition it contains starch, which is present neither in milk nor beef, but in smaller proportion than in wheat, of which it forms 59·7 per cent. Comparing cocoa with milk, we thus see the former is richer in the nitrogenous substances analogous to those contained in milk, and that the fat also exists in a considerably larger proportion. The same remark applies to beef, and it further contains valuable substances which they do not possess. In wheat, the starch appears to hold the place that the butter takes in cocoa; otherwise, their composition has great similarities, but cocoa has again the advantage of possessing qualities which the other has not. The value of cocoa as a food is thus apparent, and fully justifies the high eulogiums which have been passed upon it by so many men eminent in science. I have noticed the large amount of fat that cocoa contains, and its especial value on account of its non-liability to become rancid. Its presence, therefore, constitutes cocoa as essentially a heat-giving food, of which class it is certainly the most valuable: and its value as such is fully recognized by the instincts of the people who use it much more largely in cold than in warm weather. Drs. Miller and Letheby, amongst many other authorities, state that cocoa owes its chief value to its cocoa-butter, and to this is undoubtedly due the benefit which consumptive patients derive from its use. But its possession also, in so rich a degree, of albuminoid substance, theobromine, and phosphatic salts, renders it almost equally valuable in other ways. Unlike tea and coffee, whose virtues can be extracted by infusion, and the non-soluble parts of which are useless as food, the whole substance of the cocoa nib, if properly prepared, can be taken into the stomach, and all but an inappreciable amount digested. The object of the manufacturer should therefore be, to prepare the raw cocoa in such a manner that the whole of its valuable properties shall be preserved to the consumer; that it shall be easy of preparation, and of such a price as to be within the means of the bulk of the population, for whom it is especially valuable, and far superior to tea or coffee. We will therefore proceed to consider how this end is best gained, and the modes of manufacture practised in this country; with their influence in causing the great increase which has taken place in the use of this food.

For many years after the introduction of raw cocoa into England, its manufacture was conducted in a very rude manner, no attempt being made to separate the husk of the cocoa nut from the nib. The mode of manufacture was to grind the whole bean with sugar and farinaceous substances. This was then either run into rude blocks and called rock cocoa, or cut into cakes or long rolls somewhat of the appearance of short rulers, and sold under the name of cake or roll cocoa. Gradually an advance was made in this rude method of manufacture, and in the preparation of what was called chocolate an endeavor was made to imitate the Spanish manufacturers. This led to the husks being carefully removed, and the ground nibs alone incorporated with sugar, or sugar and farina in the manufacture of what was called chocolate. The mode adopted in the manu-

facture of chocolate was to roast the nuts, and when cool, to break them down and separate the shell from the nibs. The nibs were then again subjected to a further roasting, and the extent to which this process was carried, then gave the distinctive character to the chocolates produced in different parts of Europe. The cocoa nibs were now placed upon a heated smooth stone, and crushed with a roller until the nibs assumed the form of a smooth paste which was then mixed with sugar, and sometimes some farinaceous substance. Various spices were also now incorporated, according to the flavor desired, and the mass when thoroughly mixed was placed in moulds, where it remained until cool and ready to be turned out.

Another form of cocoa, called flake, was also much used, and this consisted only of the cocoa beans, shell, and nib, crushed in a mill into the form of flakes.

Notwithstanding the inherent value of the food, none of these productions, however, met with any great consumption. They were all expensive, but the finer cake chocolates were of so high a price as to be only obtainable by the wealthy. The cocoas besides being dear were also unpalatable, and owing to the presence of the husk, very indigestible and irritating to the internal mucous membranes. Both kinds, in addition, labored under the disadvantage of requiring boiling.

This drawback, which is common to all cocoas and chocolates of foreign manufacture, does not appear in Spain and France to have militated against their large consumption; but for some reason or other—whether it be that we do not as a nation like trouble where it can be avoided—the tedious and somewhat unpleasant process of first having to scrape and then boil the cake of chocolate, carefully stirring the while, and afterwards milling it, has never found favor, and this is one of the reasons that its use was so limited until the last fifty years.

The removal of this drawback is due to Mr. Daniel Dunn. After a long series of experiments in relation to the treatment of cocoa, he found that by making a slight variation in the mode of the preparation and mixture of the sugar with the cocoa nibs, he was able to produce a substance in the form of paste, which only required the addition of boiling water to be ready for use. This cocoa or chocolate paste was the first form of soluble cocoa ever made. From the first, he discarded, in his preparations, the barbarism of grinding up the husk with the cocoa nib, a practice both wasteful and unwholesome.

Having succeeded in producing in the form of paste, a cocoa which did not need boiling, it was found that a serious drawback existed from the need of its being contained in earthernware pots or other vessels. These were not only inconvenient, but being expensive and heavy, they added both to the cost of production and transit. Mr. Dunn therefore further pursued his experiments, and found that by varying his process so as to reduce the amount of moisture, he was enabled to bring the paste into a condition sufficiently hard to enable it to be cut; at the same time the soluble properties still being retained. The cakes had the disadvantage, however, of requiring to be scraped into the cup, a somewhat sticky process; and were also not very pleasing to the eye.

Mr. Dunn, still pursuing his investigations, found that by adding some farinaceous substance (he preferred and only used arrow-root), he could bring the cocoa into the form of a powder, which was more readily miscible even than his previous preparations. This form is the most convenient one in which cocoa can be prepared, and although, from the price usually paid, we are accustomed to preparations somewhat inferior in flavor to the finer French chocolates, there is no difficulty in making a soluble cocoa or chocolate powder quite equal in quality to them. The mode of manufacture of soluble cocoa or chocolate powder is as follows. The raw nuts are first picked in order to remove any mouldy or damaged nuts, the presence of which would injure the flavor of the cocoa. The picked nuts are then placed in revolving heated cylinders. When sufficiently roasted—a process which takes from three-quarters of an hour to an hour and a half—they are either spread out thinly on a grating, or placed in coolers so constructed as to offer a large conducting surface, and are thus rapidly cooled down. The roasted nuts are then conveyed to a kibbling mill supplied with fans; the cocoa is here broken down and the shell winnowed from the nib. When this operation is fully effected, the nibs are slightly warmed before being ground.

A cocoa mill constructed to reduce the nibs into a fine paste consists of two parts, viz., the feed-mill and the grinding-mill. The object of the feed-mill is merely to regulate the supply of cocoa sent into the grinding-mill. The latter is not unlike a flour-mill, consisting of a horizontal bed, on which revolves a runner. These mills have to be heated, and the cocoa runs from them in a smooth, semi-liquid condition, when it is ready for incorporation with the sugar and farinaceous substances with which it is to be mixed. It is afterwards reduced to a powder. This powder may be made either fine or coarse, it being a question of merely manipulative process, which has no relation to quality. If required very fine, it may have to be more completely pulverized in another mill. But whether coarse in grain or fine matters not; the cocoa is the same in quality. That is, either fine or common preparations may have either appearance. With slight variations of process, this is the only way in which soluble cocoa powder can be produced; that is, it must contain sugar and farina. The cocoa being in the first place very finely ground, the sugar causes it to mix readily, while the farinaceous substance holds the particles of cocoa in suspension, and the whole forms an emulsion.

This mechanical suspension renders the particles of cocoa more digestible, and keeping the globules of cocoa-butter in a finely divided condition, they also are more readily assimilated. Thus the farina, in addition to its important office in aiding in the production of powder, has another distinct advantage. It really causes the cocoa-butter to be in a similar condition, as regards the cup of cocoa, that the fat globules of milk are in before rising to the surface as cream. And it does not need any deep physiological knowledge to know that we can take in milk a considerable quantity of these fat globules without inconvenience, whereas the same amount taken in the more concentrated form of cream would produce indigestion and biliousness. Some chemists have denied that this effect is produced in cocoa by the addition of farina: but by practical experiment I can vouch for the fact. The reason they have fallen into this error is by looking at the subject only from the chemist's view, and not from that of the practical physiologist, and assuming that such a result could only arise from a definite chemical action produced by the farina on the fat. This is not so; there is probably no such action; but by separating the particles of fat, that is forming an emulsion, they are presented to the stomach in a form in which they can be readily assimilated.

As I have before said, soluble cocoa powder is of

necessity a compound substance, and should consist only of cocoa, farina, and sugar. Unhappily, excessive competition, and the desire on the part of the public to obtain greater value for their money than is possible to be given, has caused several forms of adulteration to be practised in cocoa manufacture. The more harmless of these is the addition of animal fat to cover the use of a poor cocoa, and to enable the addition of an excessive quantity of sugar and farina; but, unfortunately, as one sin often leads to many, the result thus obtained requires further "doctoring" to render it acceptable to the public taste.

Cocoa, thus adulterated, would be poor in flavor and light in color, and therefore the adulterating manufacturer must add something, which, while cheap, will impart a flavor which under much disguise may be mistaken for cocoa. With this view chicory is added, and this is the most harmless of the adulterants used for this purpose of disguise. It is, however, a fraud, as the only object of its addition is to impart a flavor which shall be mistaken by the consumer for that of cocoa, which he will imagine present in larger quantities. *Terra japonica*, or catechu, as well as other substances, has been used to produce the same effect. Curiously enough these adulterations appear to have baffled the analytical chemists, and this probably because of their addition in the form of concentrated decoctions. We have thus got a cocoa adulterated with foreign fat and chicory, and other flavoring substances, but we have not yet reached the end of these additions. The cocoa now, although seemingly rich in butter and of strong flavor, is not yet sufficiently pleasing to the eye, and therefore the adulterator adds some mineral coloring substances—the most harmless in use being perhaps peroxide of iron—but there are others, amongst which figure such abominations as red-lead and cinnabar, or sulphide of mercury. But for the credit's sake of even our dishonest countrymen, we must hope such fiendish modes of adulteration as those just mentioned are no longer practised.

I have thus sketched the mode of manufacture of soluble cocoa powder, and have glanced at some of the frauds practised in its manufacture. As I have already stated, soluble cocoa powder can only be obtained by the addition of certain substances to the cocoa. But the cocoa nib can be flaked or ground into a coarse powder by itself, or, a portion of the fat being extracted, it can then be reduced to a fine powder. This mode of preparation is practised in what are improperly called the pure cocoa powders, but these cannot be regarded as cocoa pure and simple any more than can those prepared with farina and sugar. In them a larger quantity of the most valuable portion of the substance of the cocoa bean is abstracted, and it is, indeed, thus rendered analogous to skim-milk. Now, skimmed cocoa, like skimmed milk, is very good in its way, and when it is required, as it is in some diseases, but as the principal object in most cases in drinking cocoa is, or should be, the consumption of all the good qualities of this valuable bean, the unnecessary abstraction of the fat is greatly to be deprecated. The mode in which these powders are prepared is by subjecting the ground nibs, which are usually placed in bags, to strong pressure, the press being heated. The cocoa butter then slowly runs off in the form of oil, which quickly solidifies on cooling, and a hard mass is left in the press. This is afterwards broken up and powdered in mills, and after being dressed is ready for use. Unfortunately this form of cocoa powder is as liable to adulteration as are the mixed ones, and one of these, which has at the present time a great reputation, contains ash greatly in excess of what would be yielded by pure cocoa so prepared, and thus points unmistakably to the use of some adulterant.

These powders also have the disadvantage of bejng very expensive, ranging from 2*s*. 8*d*. to 6*s*. the pound, while soluble cocoa powders range from 6*d*. to 1*s*. 8*d*. They are, further, not so miscible in boiling water, but require further boiling, and even then the particles sink to the bottom of the cup, and are thus wasted.

This objection also applies, but in a greater degree, to the use of flaked cocoa, and plain and ground nibs. However much these forms are boiled, but little substance is really dissolved, and the gluten is especially lost. When we also consider that in the cocoa made from the nibs or flaked cocoa the fat is generally carefully skimmed off, and the residue or grounds are thrown away, we must see how sinful a waste is made of this food when used in such a manner. This is apparent when we remember that with the exception of about 5 per cent., the whole substance of the nib is valuable as food, and, when properly prepared, digestible as such. In the beverages made in the way I have described, the nutritive value derived is reduced to its minimum, and is but slightly greater than could be obtained by an infusion of the shells, which contain a small proportion of theobromine, and can be obtained for 2*d*. per pound. I may here mention that these shells are largely used in Ireland for the purpose of calf feeding, and also by the poorer people. They make an infusion with them, which is not inappropriately called "miserable." There are a few persons who use even nibs and flaked cocoa, and perseveringly consume the whole substance of the nib or bean, as the case may be; but they very speedily have to give up the use of cocoa from the dyspepsia which results from taking it in so rich a form. A glance at the composition of cocoa will fully explain this fact, from the highly concentrated form of nourishment it presents.

The present mode of making French chocolate in cakes differs somewhat from the mode of producing soluble cocoas. The nibs are placed in a heated mill, called a *melangeur*, formed of a revolving granite table, with two heavy granite runners. When brought to the consistency of a smooth paste, sugar or sugar and farina (as is the case in the cheaper qualities) are added, and the whole well ground and mixed together. When thoroughly incorporated, the mill is cleared, and the partially prepared chocolate is passed between three horizontal rollers, which thoroughly crush any particles not previously sufficiently ground. This operation is repeated several times, to bring the chocolate into a perfectly smooth condition; it is then again placed in the *melangeur* to be finely mixed, when it is ready to be moulded into cakes or fancy forms, or to be used for covering the bon-bons called chocolate creams. The mode of moulding the cakes is first to weigh the chocolate, which is then put into a number of moulds placed on a tray to receive it. It is then removed to a table, to which, by means of an intermittent action, a strong vibratory motion is communicated, and this shakes the chocolate well into the moulds, from which, when perfectly cool, the cakes can be turned out. A circumstance to be noted is that these are then in a highly electrified condition.

Having thus briefly explained the mode in which cocoa and chocolate are prepared, I would now conclude with a few words touching the operation of the "Adulteration of Food Act" as it affects cocoa.

This act of Parliament, so ill considered and faultily

arranged, was not deemed of sufficient importance by the House of Commons to be worthy of their careful attention, and it was at an important stage shovelled through a bare House at two o'clock in the morning. Its further progress was then the result of a stratagem, participated in by one of its prominent supporters and a member of the Upper House; and the bill was finally passed in the House of Commons by about twelve members. It is not therefore surprising that it should have proved impractible in working and been the cause of much oppression and injustice. The wonder is that it has produced any good results, although even these are already diminishing, owing to the odium it has excited having already caused the commencement of a laxity in its enforcement. The subject of food adulteration is one of the most intricate and difficult on which to legislate, and one on which hasty legislation is most strongly to be deprecated.

The result of the present act has been not so much to check the real adulterations which are practised, as to harass small tradesmen caught tripping, on what are really technicalities. Whether it be that the amount of adulterations has been greatly exaggerated, or that the present race of analysts is unable to discover them, I know not; but certain it is, that almost the only adulterations they have detected have been the mixture of water with milk, and of chicory with coffee, the color facings of teas, and the circumstance that wheat flour and turmeric frequently exist in prepared mustard, facts that were perfectly patent to everybody. An effort has also been made, but unsuccessfully, to bring mixed cocoas within the category of adulterated articles; but, unfortunately for the public, not a single case of really adulterated cocoa or chocolate has been prosecuted, although large quantities adulterated with chicory, animal fat, and mineral earths, are daily sold throughout the country. Of course I am aware that no act of Parliament can supply discretion and intelligence to its administrators; but still it is to be regretted that one dealing with so all-important a subject should not have been more carefully prepared. Looking at it merely as it affects manufactured cocoa, we find all the prosecutions under it have broken down with the exception of two or three cases which were not properly defended, and in which adverse decisions were pronounced by country justices ignorant of the merits of the case.

Any adulteration act, to be successful in working, and which, while protecting the public against fraud, does not commit injustice against the trader, must be very comprehensive; and it is impossible to put, in a few short clauses, the power of dealing with all the various substances we use as food, especially those of a mixed character, such as cocoa, condensed milk, etc. It appears to me that the difficulty would best be met by appending, in the form of a schedule to the present or an amended act, a list of the various mixed foods we take, and of what they should consist; but such a schedule could only be successfully compiled after an examination by a commission of the House, of practical as well as scientific men.

As regards the manufacture of cocoa, I most indignantly deny that the admixture of sugar and farina are adulterants in any sense. They are, as I have shown, necessary to make the article of commerce known as soluble cocoa, which, from being the form in which it is generally used, is known simply as cocoa. The public is but little acquainted with the raw nut, which, as I have said, is almost useless as a food without considerable preparation. Those, however, who like the unmixed forms of cocoa, obtain them at the shops by asking for them under their appropriate names. They are the raw and roasted, and flaked nuts, and roasted, ground, and flaked cocoa nibs. These forms of cocoa have been accessible to the public almost since its introduction in this country, but have never been largely used on account of the time and trouble required to prepare beverages from them, the unsatisfactory nature of the result, and the wastefulness attending such a mode of use. We have seen that the only way to reduce cocoa into an elegant powder is either by admixture or abstraction; and in the earliest record we have of the use of cocoa as a food in any form, that it has been always prepared with other substances; the instinct of the Indian leading him to the same result as that obtained by civilized man. This necessity has not only been fully recognized and sanctioned by high scientific authority, but also by act of Parliament (3d Geo. IV., c. 53) passed in the year 1822, to regulate, amongst other things, the manufacture and sale of cocoa. It is therein provided that it shall be lawful to manufacture "cocoa paste, broma, and other mixtures and preparations of cocoa with sugar and arrowroot flour, or other farinaceous powders; such arrowroot flour, or other farinaceous powder not being baked, scorched, roasted, or otherwise disguised or altered from its natural state, except by being mixed with cocoa as aforesaid." The latter provision is an instance of how favorably some of these old acts compare with much of the over-hasty legislation of the present day, in the care with which they were prepared; for it takes in the whole question of cocoa adulteration, and while not, on the one hand, prohibiting its preparation with other substances, yet guarding against a fictitious appearance of strength being produced in fraud of the consumer.

In the interests of honest cocoa manufacturers it is highly desirable that this clause should be incorporated in any future legislation, and a further enactment be made requiring a specification of the different ingredients employed. The proportions in which these are mixed it would not be just to require, as in this constitutes the difference of one manufacturer's preparation from another, and any such statement is quite unnecessary if the consumer is protected against deception, as he will then be able to judge fully the quality of his cocoa, and will refuse to take those preparations in which the admixture of sugar and farina is pushed to excess. Amongst the numerous eminent scientific men who have given their sanction to this mode of preparation, I will only name Drs. Periera, Johnson, and Ure, and Messrs. Tomlinson, Brande, and Cooley, all Fellows of the Royal Society. The testimony of Drs. Normandy and Letheby is also of great value. The former states that "the preparation known as cocoa powder or chocolate powder, when genuine, consists only of cocoa nibs, sugar, and arrowroot," and states that the "butter of cocoa is thereby rendered emulsive and more digestible." Dr. Letheby states that cocoa and chocolate owe their chief value, as food, to the fat they contain, and further states, "it is necessary to reduce it with some easily digestible substance." Johnston, in his "Chemistry of Common Life," states "that the presence of the cocoa-butter justifies also, as fitting it better for most stomachs, the practice of mixing the cocoa with sugar and farina," and says, "both practices are skilful chemical adjustments." The testimony of Dr. Ure is perhaps the most important of all, he having been appointed by Government to inquire into the manufacture of cocoa for the navy in the year 1842. The reason of his appointment

was, that the cocoa as then made at Deptford Victualling Yard was found to produce a spurious form of dysentery amongst the men. Dr. Ure soon discovered that this arose from the practice of grinding the whole nut, husk and nib, in a coarse and ineffective manner. He therefore conducted a series of experiments, which led him to recommend to the Lords of the Admiralty the preparation of a chocolate combined with sugar and farina, but freed from the husks. This form is still used, and its value is shown by the fact that the virtues of navy cocoa are proverbial. That Dr. Ure should have arrived quite independently at conclusions so similar to those formed by Mr. Dunn so many years previously, is a source of satisfaction to that gentleman's representatives. The opinion is of the greater value from the fact that he is the only chemist of eminence who has studied this question with a view to practical results.

These facts show conclusively how unjust and unwise it is to assert that manufactured cocoas prepared with sugar and farina are adulterated articles, and it surely was never the intention of the legislature—even of the dozen members who passed the bill, to annihilate a large industry supplying the public with so valuable a food in the best, and, indeed, as far as the poor are concerned, in the only way it can be rendered available for consumption.

The cocoa powders prepared without admixture, but which have a large proportion of the fat extracted, are deteriorated in value by such treatment, are not readily prepared, and are so expensive as to be beyond the reach of all but the wealthy classes. Yet this mode of preparation is justifiable, and in certain cases even desirable; the consumer being aware of the kind of preparation he is buying. The objection has been made to the use of sugar and farina that they are of less value than the cocoa with which they are admixed. This is perfectly true, but would also be an objection to almost every mixed article of food; and the effect of competition gives the full benefit in the difference of their price to the consumer, except in the cases where disguising adulterants are employed. The addition of sugar and farina to cocoa has also been objected to on the ground that, being carbonaceous elements, they are added to a substance which already contains them in excess. This would be a very valid objection were we condemned to exist on cocoa only; but as it is only one of many foods, it falls through. The necessity also exists of taking the carbonaceous elements in each of its different forms, and the presence of the cocoa-butter does not render them less necessary in the form of starch or sugar. The fact is, the deductions of mere theoretical chemistry have been pushed too far, as applied to the food of man. I do not wish, however, to disparage such investigations, or to deny their beneficial results when brought to aid the observations of the practical physiologist, and when kept in proper subordination. But it is undeniable that the instincts of man are a far safer guide as to the foods he requires, than mere chemical dogmas, founded on abstruse considerations, which vary from time to time. Reliance on these has, on more than one occasion, produced painful results in our work-houses and public institutions; and but recently Mr. Brudenell Carter, F. R. C. S., pointed out in how great a degree the recent epidemics of ophthalmia which have scourged our schools were due to insufficient dietaries, prepared, however, on the most abstruse chemical principles. He says that in the matter of food supply even the street Arab is in a better condition than some of these poor children.

The popularizing of cocoa as a food was greatly aided by the reduction of the duties on the raw material. Until the year 1832 the duty on cocoa was 6*d.* per pound; it was then reduced to 2*d.*, and in 1842 to 1*d.* per pound, on that produced by our own colonies. A larger duty was levied on foreign produce for a time, but later on was wisely taken off, and the duties equalized. The duty is now 1*d.* per pound on all raw, and 2*d.* per pound on all manufactured cocoa imported.

From these causes in combination, the consumption of raw cocoa has risen, as shown by the following tables, from 276,321 pounds in 1820, to 8,311,023 pounds in 1872, an increase equal to nearly thirty-three-fold in about half a century.

Amount of Cocoa Duty paid for Home Consumption.

Year.	No. of lbs.	Year.	No. of lbs.
1820	276,321	1860	4,583,124
1830	425,382	1870	6,943,102
1835	1,084,170	1871	7,333,988
1840	2,645,470	1872	7,853,165
1850	3,080,641	1873	8,311,023

Consumption of Cocoa per Head in Great Britain (W. Hoyle).

Year.	lbs.	Year.	lbs.
1841	0·08	1868	0·17
1842	0·07	1869	0·19
1843	0·08	1870	0·20
1844	0·09	1871	0·23
1845	0·09	1872	0·23

So great a result is not only gratifying as a mere matter of commercial statistics, but in a higher degree as showing the wide and extending appreciation and use of so valuable a food.—*Journ. of Soc. Arts.*

THE ISINGLASS OF COMMERCE.

BY P. L. SIMMONDS.

Isinglass, one of the purest and finest of the animal glues, is a product the preparation of which was long carried on almost exclusively in Russia, and chiefly obtained from the sturgeon. The value of the isinglass from this fish is chiefly due to its peculiar organic texture, on which the property of clarifying wines and beers depends. No artificial isinglass, however pure the gelatine, or identical as to chemical composition with the air-bladder of the sturgeon, answers the purpose of the preparers of fermented liquors.

Isinglass is brought to market in different forms; sometimes in that of plates or lumps, or in the form of a bag or purse, at other times rolled up in different shapes, which pass under the names of book, leaf, long and short staple, tongue or pipe, and it is cut into fine threads. When of good quality, isinglass is of a whitish color, thin, and semi-transparent, but tough and flexible, destitute of taste as well as of smell. The inferior kinds are thicker, yellowish colored, opaque, and sometimes have a fishy smell and taste. When placed in cold water it becomes soft, then swells, and if held up to the light in this state is opalescent. In boiling water pure isinglass is entirely dissolved, with the exception of a very minute proportion of impurities. Though the best isinglass is thus completely dissolved in hot water, yet most of that found in commerce does not become so, in consequence of the presence of albuminous parts.

Isinglass, being mild and unirritating in nature, and at the same time nutritious, is much employed as an

article of diet for the sick and convalescent, and the fine shreds, into which it is cut and kept in shops, give great facility for making a jelly in the shortest possible time. This can be made palatable and nourishing by the addition of sugar and milk, acids or spices; about one-third or half an ounce is sufficient for a pint of water. It may also be taken in the form of a soup, with the addition of salt, spices, and sweet herbs, or it may be employed medicinally as a demulcent, either externally or internally. The best kinds of isinglass are alone employed in articles of diet and for the best confectionery, being added in small quantities to other, especially vegetable, jellies to give them a tremulous appearance; but gelatine is now frequently substituted. The sources and statistics of some of our isinglass supplies are not very well known in ordinary trade circles, and therefore some details may prove interesting.

The aggregate import of isinglass has largely increased in the last 20 years, and the sources of supply have much changed, for we are now less dependent on Russia, India and the Eastern countries furnishing the largest amount we receive. In 1853, 2284 cwts. received, 1056 cwts. came from Japan, and in 1858 the proportion of Russian was 1184 cwts. out of 2026 cwts. It still fetches the highest price. In 1871 Russia only furnished one-fourth of our aggregate supplies. The total imports of isinglass into the United Kingdom in the five years ending with 1871 were as follows:—

	Cwts.	Value.
1867	2732	£79,746
1868	2853	81,085
1869	3287	84,755
1870	3530	83,022
1871	4266	72,189

Isinglass, in common with many other of the minor articles of import, has been struck out of the Board of Trade returns the last two years.

Russian Isinglass.—This principal kind is so well known, and has been so often described, that I shall not say very much respecting it, devoting the descriptive details chiefly to the other varieties which enter into commerce.

Isinglass is obtained in Russia from the interior lining of the swimming bladder of the sturgeon (*Accipenser*) the *Silurus*, and the large carps. The *Coregonus leucichtys* also furnishes some. The relative value of these may be judged of by the prices given in the Russian Exhibition Catalogue, per poud of 36 pounds avoirdupois:—

Isinglass from the	Sturgeon	120 roubles.	
" "	Sterlet	100	"
" "	Stellifere	80	"
" "	Coregonus	60	"

Our imports of isinglass from Russia were, in 1853, 1056 cwts., and in 1858, 1184. Of late years it will be seen that there has been a gradual decline, as we get more from the Eastern seas.

Imports from Russia:—

	Cwts.	Value.
1867	1050	£47,038
1868	1018	45,601
1869	890	37,402
1870	873	32,359
1871	744	27,196

The bladders are left some days in water, which is frequently changed, in order to remove the fatty and bloody particles; they are then withdrawn and cut lengthwise into sheets, which are exposed to the sun and air, the outer part being attached to boards. The inside, which is formed of layers of pure isinglass, is carefully detached from the exterior layers, wrapped in linen, and pressed, in order to keep it from contracting; it is then made up into parcels according to size. The parcels of isinglass of the large sturgeon are composed of from 10 to 15 sheets, and weigh about 1¼ lb.; those of the ordinary sturgeon contain 25 sheets, and weigh one pound. These parcels, to the number of 80, are packed in a linen bag, covered with rush matting, and sent away sealed with lead. 38 lbs. are worth, at Astrakan, from 19*l.* 4*s.* to 28*l.* 16*s.*, according to quality. The air bladder, although deprived of its internal parts, still contains a little isinglass, which is scraped off with a knife and kneaded; after being damped with water, it is made into small tablets about the size of a five-shilling piece. The sheets of isinglass of the *Silurus glanis* are placed like leaves in a book, and are dried upon small cord; it is made up into bags of 152 lbs.

Carp isinglass (*Cyprinus carpio*) is made into parcels of 30; and lastly, a good fish glue is made at Astrakan from the scales of the fish.

Vesiga.—This is the name given to the dorsal cord or tendons of the vertebral column of the larger species of sturgeons, prepared in a certain manner, and much esteemed for the table. The quantity prepared reaches the value of 20,000*l.* annually. It is first carefully washed and pressed to extract the soft matter which it contains, it is then dried and put up in packets the entire length, and folded in the middle. It is used chopped up in the preparation of small fish cakes much esteemed in Russia. The Russian poud of about 30 lbs. is worth 2*l.* 10*s.* to 3*l.* 3*s.*

Brazilian Isinglass.—From the province of Para the exports of isinglass might be very large. So far back as 1834, 255 barrels of isinglass were shipped from Brazil. In 1850, several tons of it came into Liverpool from Para and Maranham, and about 28 tons of Brazilian tongue isinglass. In 1853, 662 cwts., and in 1858, 417 cwts. One or other of the Siluroid fishes common in Guiana probably yield the Brazilian isinglass, which comes chiefly in the form of lump or pipe. The quantity now received is considerable, as the following figures of the imports into the United Kingdom will show:—

	Cwts.	Value.
1867	761	£15,763
1868	713	14,529
1869	741	16,494
1870	661	14,154
1871	883	14,356

The fish which produce this article are caught annually in great quantities at the mouth of the Amazon. The isinglass is almost all sent to Great Britain. The average price in 1866 was 30,000 reis the arroba of 32½ lbs. The shipments were, in 1865, 1755 arrobas, and in 1866, 1544 arrobas. The fish caught in the rivers are not of first-rate quality. Great quantities of piracuru (*Vastris gigas*), highly esteemed by the natives, are taken on the Upper Amazon, and sent to the Para market.

West Indian Isinglass.—Under this name the isinglass obtained in British and French Guiana enters into commerce. It is the produce of one or two Siluroid fishes. In British Guiana it appears to be obtained from the Gilbackre or Gilbagre (*Silurus Parkerii*), a fish very abundant in the estuaries of the rivers of the colony. A small quantity of this fish glue, as it is

termed, is now exported from there: In 1853, 95 cwts. were shipped from British Guiana; in 1858, 73 cwts. It was then worth about 20*l.* the cwt. In 1867, 59 cwts. were imported, valued at 1157*l.*, and in 1871, 95 cwts., valued at 1645*l.*

In French Guiana some attention has also been given to the preparation of isinglass. The exports were, in 1865, 8512 lbs., and 6176 lbs. in 1866, at the average price of about 2*s.* 3*d.* the pound. The isinglass is that of the Machorian (*Silurus felis*), and is especially employed in the clarification of beer. Reduced into small shreds by the action of a mechanical plane, it dissolves completely in cold water, and is compared with Russian isinglass as two to three. Its cheapness gives it also advantages over the latter.

North American Isinglass.—Cod sounds, which are brought in great quantities from Newfoundland, are nothing more than the salted air bladders of these fishes. The Iceland fishermen, as well as those of America, prepare isinglass of a very excellent quality from cod sounds, though they are not acquainted with the method of clarifying it which the Russians practise in preparing that article from the sound of the sturgeon.

Occasionally ribbon isinglass is imported from New York. It is obtained from the air bladder of the common hake (*Merluccius vulgaris*), or probably from the fish passing under the name of hake on the coasts of America (*Phycis Americanus*). The air bladder is thrown into water to macerate for a little while, and taken out and pressed between two iron rollers, by which it is elongated to the extent of half a yard and more. It is then carefully dried, packed, and sent to market.

In the manufacture of ribbon isinglass from fish sounds it is customary to feed the softened and moist or macerated sounds to and between feed and compressing rollers, by which the viscid substance is compressed and joined and formed into a continuous sheet. Notwithstanding the constant injection of cold water into the rolls, the substance adheres tenaciously to the roll, and accumulates thereupon, and has to be cut away; so that the operation is slow and laborious, and productive of imperfect sheets.

Mr. James Manning, of Rockport, Massachusetts, has invented an improvement, designed to so strip the gelatinous substance from the rolls that the work may proceed continuously, the ribbon, as it is stopped, being again fed or guided by the operator into and between the rolls, until sufficiently reduced or elongated for removal, or for the action of other rolls, set nearer together, to produce a thinner ribbon. He effects this result by placing at the side of each roll a scraper extending the whole length of the roll, and having an edge set up to the roll, so that the roll shall run just clear of it, which scraper or cleaner strips from the whole surface of the roll the adhering gelatine in the form of a sheet.

Knowing that the sturgeon abounded in the North American rivers, and struck by the absence of isinglass from that quarter, in 1851, Professor Owen drew the attention of the Canadian Commissioner to the fact, and now a commerce has sprung up for this valuable product, which, previous to the first London Exhibition, had been rejected among the useless entrails of the sturgeon. Now some attention has been given to the preparation of the air bladder and the outer tunic of the alimentary canal, after the modes of obtaining the best Russian isinglass. In 1853, 33 cwts. came from Canada, but in later years no distinct returns seem to have been kept.

Indian Isinglass.—The attention of the members of the Zoological Society was first directed to this subject by Dr. Cantor. In Parbury's *Oriental Herald* for January, 1839, a writer, speaking of the Suleah fish of Bengal and the isinglass it affords, says: "This fish when at its full size attains about four feet in length, and is squaliform, resembling the shark species in appearance, but exhibiting a more delicate structure. The meat of the fish is exceedingly coarse, and is converted by the natives, when salted and spiced, into 'burtah,' a piquant relish well known at the breakfast-tables of Bengal. The air bladder of the Suleah may be considered the most valuable part of it: this when exposed to the sun and suffered to dry becomes purely pellucid, and so hard that it will repel the edge of a sharp knife when applied to it. These bladders, when perfectly dried, vary in weight from half a pound to three-quarters of a pound avoirdupois. This fish abounds in Channel Creek off Saugor, and in the mouths of all the rivers which intersect the Sunderbunds, and are exceedingly plentiful in certain seasons."

The discovery of isinglass as a product of India was so important that Dr. Cantor determined to investigate the subject, and to ascertain what were the fishes which yielded it. These seemed to be principally one or two species of *Polynemus*, especially the *Polynemus Sele* of Hamilton's "Fishes of the Ganges," and the Gol or Gheriah (*Corvinus niger*). *P. Sele* is supposed by Royle to be a variety of *P. lineatus*, which is said to be common on all the shores to the eastward. A larger species, *P. tetradactylus*, is also believed to furnish some of the Indian isinglass. Several of the Siluridæ also afford it in large quantities, especially the species marked *Silurus raita* by Dr. Buchanan.

Dr. McClelland gives the following as the distinctive characteristics:—

"*Polynemus.*—The two fins on the back are distinct from each other. The tail-fin is forked, and there are five long tendrils under each pectoral fin."

"*Corvinus.*—The two fins of the back united; the tail-fins not forked, and no tendrils beneath the pectoral fins."

It may be useful, perhaps, to quote here the account furnished by the same gentleman to the Supreme Government of the method to be adopted in separating isinglass from the fish sounds, and rendering it fit for market.

"The air-vessel is from eight to twelve inches long, pointed at each end like a double night-cap, hollow, but without an opening.

"It is merely taken out of the fish when caught, and thrown aside without further trouble by the fishermen. It is at first soft and doughy to the feel, and partially distended with air, but in time it becomes collapsed and hard outside, in which state it is sold to the Chinese.

"When fresh taken from the fish, it is covered by a thin cobweb of small bloodvessels, which are easily peeled off, as none of them enter the substance of the organ. When this is neglected, it is stained and spotted with blood, and the whole becomes hard and consolidated together, or the vascular membrane itself becomes putrid in places.

"Hence the vascular membrane should always be carefully peeled off the first thing by the fishermen, when the outside will then present an appearance like white satin, of a fine oblique fibrous texture. The edge should now be slit open, and the same kind of bloody cobweb peeled from within. The inner side will then present the same white satin appearance as the outside; but, if attentively examined, will be seen to

consist of transverse, instead of oblique fibres. If it be allowed to dry, the whole becomes hard, horny, and partially transparent.

"The thickness of the organ is about one-third of an inch, and the best way to see its fibrous structure is to tear it across when it is dry. In this way it splits in the direction of the transvere fibre, of which nine-tenths of its substance consists, the oblique fibre forming merely a thin coat outside. If the mechanical division of the transverse fibre be thus continued, the outer oblique coat becomes readily detached, and falls off in plates and scales from the outside. Thus by mechanical means the organ may be separated into two very distinct parts, the first or transverse fibre, consisting of perfectly pure gelatine, comprising about nine-tenths of the whole; the second or oblique fibre falls off in broad plates, consisting of albumen, thus leaving the gelatine or isinglass perfectly pure.

"When cut open, cleaned, and dried as above, the Suleah sound weights from 12 to 16 ounces, from which 90 per cent. of pure isinglass may be separated by mechanical means. With the aid of a common vice, I can in half an hour detach in shreds the whole of the isinglass from the impure, insoluble outer rind, which falls off in scales in the process of shredding.

"The fish being caught at a distance from Bombay and Calcutta, the sounds are usually sold unopened and uncleaned, as taken from the fish, with the cobweb of bloodvessels hardened and dried upon the surface, which is frequently stained with blood.

"In this state it requires to be soaked for twelve hours in water, to overcome the horny consistence, so far as to be able to cut it open. The outer rind, being insoluble, is that on which soaking makes the least impression; so that when opened we frequently find much of the pure isinglass within dissolved; and if continued soaking and washing be practised after it is opened, with a view to soften and cleanse the outer insoluble rind, the article may become greatly impoverished and deteriorated from the solution of the inner parts, which thus become dissolved and washed away incautiously during the operation. A large proportion of the Bengal isinglass hitherto sent home was much deteriorated by this cause.

"To obviate this, it is only necessary to induce the fishermen to open the sounds at once when taken from the fish, and strip them of their cobweb, when they should merely be rinsed with a little fresh water, and dried in the sun; after which, the longer they are kept exposed to dry in free air, the better."

The late Dr. Royle, in a work entitled "Observations on the Production of Isinglass along the Coasts of India, with a Notice of its Fisheries," gave a good deal of valuable information on this subject. At the first London Exhibition, in 1851, Dr. Walker exhibited a specimen of *Polynemus plebeius*, and isinglass made therefrom, and another undescribed fish from Arracan, affording isinglass, was also shown in the Indian collection. Dr. McClelland obtained a prize medal for Indian isinglass, which in quality, after repeated trials, proved to be fully equal to the finest Beluga samples.

The following have been the recent imports of Indian isinglass into the United Kingdom from Bombay and Scinde:—

	Cwts.	Value.
1867	347	£5.598
1868	162	2,641
1869	454	7,699
1870	586	10.672
1871	525	5,460

From the Straits Settlements:—

	Cwts.	Value.
1867	255	£4.248
1868	754	12,570
1869	911	15,708
1870	1023	17.637
1871	1703	26,897

Chinese Isinglass.—Isinglass or fish glue is very extensively employed in China for a great number of purposes. This substance, which is obtained in Europe by treating principally the swimming bladder of the sturgeon, is made in China in another manner. There we meet in commerce with plates of a horny appearance, whitish and of a tissue resembling animal membranes. These plates are of different forms, and bear in China the name of ju-ka. This substance, dissolved in water, forms a glue of an excellent quality, which is specially employed by cabinet makers, furniture being an industry for which Ningpo is justly renowned. This glue has properties much resembling gelatine. Like gelatine, it is very nitrogenous, furnishing by distillation ammoniacal compounds and a bulky charcoal. This, incinerated, gives a whitish ash, composed probably of phosphate of lime.

In an industrial point of view, it differs from isinglass by furnishing a glue of very considerable resistance. That of the best quality is reserved for the manufacture of furniture of the highest class, and is employed to unite pieces of wood which are required to resist great strain. Besides its industrial uses, this fish glue is highly esteemed for food purposes by the Chinese.

The three kinds of fish chiefly used for obtaining isinglass in China, are: 1. The My-yu (*Sciæna lucida*), having grayish scales; 2. Ta-houang-yu (*Otolithus maculatus*), the head, fins, etc., of which are of a bright yellow; 3. Mung-yu (*Anguilla* (*Muræna*) *pekinensis*, Basilewski). To obtain the swimming bladder the gills are removed, and by introducing the finger into the interior the air bladder is obtained. The intestinal and membranous parts which surround this organ are separated, and with a knife it is split longitudinally; the two lips are lifted, and a whitish membrane which is found on each side is taken out. In this state it is sold for food purposes. It is boiled a certain time in water, but does not dissolve, forming only a gelatinous mass of an insipid flavor. With the third-named fish, of the eel species, the belly is opened, and the organ, which is often of great size, removed.

The glue which is made is of excellent quality, but often yellow or gray tinted, according to the inferior quality of the substance employed. It is thus prepared: The ju-ka is washed in water for about two hours, then taken out and placed in a water-bath for a certain time. When, by the touch, it is found to be soft, it is removed and beaten with a heavy iron hammer. This is said to be a delicate operation, which should be done at the proper time. The substance is then flattened and rolled by the hand, and horizontal incisions are made so that the air may more readily reach, and the drying be more rapid. When the glue is to be used, it is broken in pieces, put in a water-bath, with a little water to dissolve it.

It is probable if the Chinese isinglass were treated with sulphurous acid a better commercial product might be obtained.

Besides its use for food purposes in China, isinglass is employed medicinally in cases of hemorrhage, in certain puerperal affections, to facilitate labor, and forms the

base of many external applications; mixed with soot it is used in cases of leprosy and psoriasis.

Isinglass is most esteemed in China when it is very transparent. It is usually met with in long, channelled pieces, transparent, of a dull-yellow color. Gelatine is often substituted for it, which is in long, opaque tablets, of a deep brown, and which is made from the skins of different animals.

In many of the French colonies it is stated that large quantities of valuable isinglass are lost to commerce from carelessness and ignorance. At Senegal and at Mahé the swimming bladders are thrown away with the entrails. At Newfoundland they form part of the food of the seamen, and a few barrels are sent to France. From Cochin China a small quantity is shipped to China.

FISH MAWS are the swimming bladders or sounds of different fish, extracted and merely dried in the sun. They are extensively prepared on the Malabar coast and exported to Bombay, from whence large quantities are re-exported, principally to China and the Straits Settlements. In the official year ending 1872, 9008 cwts. of fish maws and sharks' fins, valued at 30,100*l.*, were exported from Bombay.

SHARKS' FINS (from *Rhyncobatus lævis*, Mull.) are also largely exported from Bombay and Madras to China, where they are much esteemed, being used for making soup. So great is the consumption that on the average from 7000 to 10,000 cwts. are annually imported there from Bombay. These fins are assorted into the "white" and the "black," the former being the dorsal fins, which are uniformly light-colored on both sides, and are reputed to yield more gelatine than the other; the "black" fins are the pectoral, ventral, and anal fins. This variety is less esteemed than the white, and consequently realizes a lower price.*

Sole skins, if clean, sweet, well prepared and dried, can be used as a fining agent, and are sometimes employed in households to clarify coffee.

It may be mentioned that the stomach, the intestines, and also the skin of different kinds of fish, can be used as isinglass after being cut and submitted to the action of boiling water, and then pressed, which gives the substance the appearance of thin leaves, resembling parchment.—*Chemist and Druggist.*

* Catalogue of the Indian Department, Vienna Exhibition.

A FEW OBSERVATIONS ON COAL.

BY E. W. BINNEY, F.R.S.

A Paper read before the Manchester, England, Philosophical Society.

Of late years much has been written on the structure of coal and the various vegetable remains of which it is composed. Observers, examining different coals under the microscope, have, as might be expected, come to different conclusions. Some of them have found little else than the remains of spores and spore cases, others only scalariform and cellular tissues and a few spores, and, a third class, little trace of any structure whatever in the specimens they examined. Splint or hard coal would generally afford the results first named, soft caking or cherry coals the second, and cannel coals the third. Soft coals, yielding a large amount of charcoal inclosed in bright coal, nearly always show plenty of structure in the "mother coal," as well as a few macrospores in the bright portions. Macrospores are nearly always found in abundance in splint and hard coals. In cannel coals they are sometimes found as well as the cellular and scalariform portions of plants. For many years macrospores were known by the names of spore cases and spores. They could be easily observed by the naked eye in the black parts of the coal, and they were generally considered as sporangia; but Prof. Adolphe Brongniart, in 1868, described a cone (Lepidostrobus Dabadianus) having sporangia full of very minute spores, in fact microspores, in the upper portion, and sporangia full of macrospores, which had been so long known, in the lower part. These observations of Brongniart have been amply confirmed by specimens from the British coal fields. Thirty years ago it was considered that the soft or cherry coals were chiefly composed of the remains of large plants such as Sigillaria, Lepidodendron, etc., while caking coals were formed of plants of a lesser size and much bark, for it has been observed, and since confirmed, that the outsides of Sigillaria, and other fossil trees, sometimes reaching to 2 or 3 inches in thickness, were chiefly composed of bright soft coal showing little traces of structure. In the great lawsuit which was tried at Edinburgh more than twenty years since as to the nature of Boghead coal, much evidence was given as to its structure, some witnesses finding it scarely anything else than the remains of vegetables, whilst others found only a stray portion of scarlariform structure or a macrospore. Both Boghead and the other brown cannels of Scotland are now generally considered to afford but little evidence of vegetable tissues under the microscope, although numerous remains of Sigillaria and other common coal plants can be seen by the naked eye in them. Notwithstanding that they are so rich in volatile matter, and far exceeding other coals in their yield of paraffin and paraffin oils, they contain from 25 to 30 per cent. of mineral matter in the form of ash. This circumstance has induced certain scientific men to class them as shales rather than coals, notwithstanding that they have the specific gravity of coals. Some years since, when describing several fossil cones affording both kinds of spores, the writer expressed an opinion that the yellow matter seen in the vesicles of Boghead coal was nothing but microspores composed of paraffin or a similar hydrocarbon, and that they were driven off by heat in the form of a yellow vapor, leaving nothing behind but a spongy mass of earthy and carbonaceous matter. The evidence that caused him to come to this conclusion was that the microspores contained in the upper sporangia of Lepidostrobus Harcourtii had all the appearance of crude paraffin, and were of the same yellowish-brown color as powdered bog-coal, and that the latter substance was composed nearly altogether of microspores and mineral matter. So far as his observations extended microspores had not been observed in coal, although plenty of macrospores, which are generally 1-20 to 1-25 of an inch in diameter, and easily seen by the naked eye, had long been noticed. He had some time since directed his friend, Mr. J. W. Kirby, of the Pirnie Coal Company, to examine the Fifeshire seams of coal in search of microspores, most of those beds yielding macrospores in great abundance, and that gentleman had lately furnished him with the specimens now exhibited, both splint and soft coals, but especially the former, affording the two kinds of spores. On burning the yellow coal composed of microspores, a most brilliant flame and a peculiar empyreumatic odor, like that from burning Boghead coal, were produced, whilst the splint coal full of macrospores only burnt

and smelt like ordinary hard coal, thus clearly showing that these two kinds of spores differed very much in their inflammable properties and odors given off, and that such properties were certainly not due to the larger spores, but most probably to the smaller ones. The compressed lenticular bodies in the splint coal were formerly of oval and sperical forms with a triadiate ridge on one half, and although their exterior was composed of a brown coriaceous substance their interior was full of white carbonate of lime, or bisulphide of iron, according to the nature of the matrix, in which they were found; thus suggesting the idea of their having been filled with granules of starch when in a living state, which it is probable they would have been in case of their being germinating spores. He and his late partners at Bathgate, when manufacturing paraffin oil there, had tried various means, by subjecting boghead coal to the action of ethers and naphthas, to dissolve out paraffin from it, but they had never succeeded; so the yellow matter in the coal may probably be changed into paraffin by the heat employed in distillation. Dr. Schorlemmer, F.R.S., who has been so kind as to examine the microspores found in the Muiredge splint coal, is of opinion that they are not composed of paraffin, but some other hydrocarbon. This may, therefore, change into paraffin by the application of heat in a similar way to what the yellow matter in boghead coal does. The macrospores are about 320 times the size of the microspores, and constituted the germinating spores, while the microspores were the fertilizing agents, both having been contained in one cone. Several specimens of fine bright soft coal, between two and three inches in thickness, taken from the outsides of Sigillaria and other fossil trees, were exhibited. In these there was no appearance of charcoal spores, or vegetable structure, and in every respect they resembled the black shining parts of soft cherry and caking coals, which generally afford no distinct traces of vegetable structure. Hence from his observations he was led to conclude that soft or cherry coal was chiefly composed of the bark, cellular tissue, and vascular cylinders of coal plants, with some macrospores and microspores. That caking coal had much the same composition, except that it contained a greater proportion of bark in it. That splint coal had a nearly similar composition, but with a great excess of macrospores. The cannel coal, especially that yielding a brown streak, was formed of the remains of different portions of plants with a great excess of microspores, which had long been macerated in water. These conclusions were arrived at merely as to the composition of the different kinds of coal. No doubt each seam would be materially affected by the nature of the roof, whether the latter was an open sandstone or a close and air-tight black shale or blue band, for the former would allow the free escape of gaseous matter, and the latter would prevent its escape. It is well known that the character of the roof has a deal to do with the quality of the coal under it.

SALICYLIC ACID—A NEW ANTISEPTIC.

Hitherto salicylic acid has possessed only theoretical interest on account of the occurrence of its methyl ether in wintergreen oil and because of its close relation to the phenols and benzoic acid. But Professor Kolbe has shown a possibility of its extensive practical application, and has at the same time discovered a method of making it cheaply in large quantities. He says: "After many months' trial, I have at last succeeded in gaining the clue which has led me to the discovery of a new, simple, and productive method of making salicylic acid. In dissolving sodium in hot phenol in the presence of a stream of carbonic acid there is always found, besides sodic salicylate, more or less sodic carbonate and phenylate. And I observed that the more of the former salt there was, the less was found of the two latter. I further observed that a product rich in sodic phenylate and relatively poor in sodic salicylate yielded richly of the latter salt when further heated in a stream of carbonic acid."

His attention being arrested by this fact, he began a series of experiments, which resulted in the discovery of the process which he describes as follows: "The method of manufacturing salicylic acid, upon which I finally settled and by which I have already prepared about 50 pounds, is the following: Saturate exactly commercial crude soda lye of known strength with crystallized carbolic acid previously fused, and evaporate in a shallow iron vessel. The sticky, dough-like mass is now heated moderately with constant stirring, being finally powdered with a heavy pestle. This dried product is sodic phenylate. It is always reddish-yellow in color, perhaps on account of partial decomposition by the oxygen of the air during the evaporation, is very hygroscopic, and must while yet hot be bottled and kept well stopped. If the sodic phenylate is moist, or contains either free alkali or carbolic acid, the results are not good.

"The sodic phenylate thus prepared is heated slowly in a metal retort in an oil or air bath. When the contents of the retort are about 100° C., begin to lead into the mass a moderate stream of carbonic acid. Let the temperature slowly rise, till after some hours it stands at 180°. After further action of the carbonic acid, phenol begins to distil over, towards the last in greater abundance. Finally raise the temperature to from 220° to 250°. The operation is finished when at this temperature, under the continued influence of carbonic acid, no more phenol distils over.

"When the reaction is finished the residue in the retort is (if the operation has been conducted properly) a grayish-white mass of sodic sodium-salicylate. The following equation represents the reaction:—

$$\left.\begin{matrix}C_6H_5ONa\\C_6H_5ONa\end{matrix}\right\} + CO_2 = \left.\begin{matrix}H\\C_6COONa\end{matrix}\right\} ONa + C_6H_5OH.$$

"The salt dissolves easily in water, to a dark brown fluid. Upon the addition of hydrochloric acid the whole forms a thick paste of salicylic acid, which contains only traces of phenol. It may be perfected by the usual methods." Curiously enough, upon repeating the experiment with potassic hydrate, not salicylic acid, but its isomer, peroxybenzoic acid, was formed.

"Knowing that salicylic acid may be easily made from phenol and carbonic acid, and on the other hand that it is decomposed into phenol and carbonic acid on heating it above its boiling point, I came to suppose that like carbolic acid it would retard or entirely prevent fermentation and putrefaction. Prof. Thiersch and myself, having experimented in this direction, find surprising confirmation of my conjecture."

To solutions of amygdalin, mustard, grape sugar, and beer, was added a small quantity of salicylic acid, and these solutions were compared with others to which none had been added. The results were most satisfactory, fermentation being checked by the addition of a very minute quantity and completely prevented by the addition of a somewhat larger amount. In the preservation of meat, too, experiments were tried with a most satis-

factory showing for this new antiseptic agent. After a month's exposure to the air the meat remained perfectly sweet, the salicylic acid with which it was impregnated being not at all disagreeable to the taste. The Professor looks to a probable practical application of that discovery by the South American meat preserving establishments. Furthermore this acid offers a substitute for carbolic acid in surgery as an application for wounds.

Prof. Thiersch reports: "Experiments thus far give good grounds for hoping that salicylic acid has all the good properties of carbolic acid and none of its drawbacks."—*Mining and Sci. Press.*

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS.

In the preparation of these abstracts the Editors are assisted by the following chemists:—

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Berichte der Deutschen Chemischen Gesellschaft zu Berlin.

No. 14, 1874.

Notices on **sulpho-ureas** and **guanidines.** — W. Weith.

Action of H_2S on **carbodiphenylimide.**—The first stage of the reaction yields sulphocarbanilide, thus:—

$$C\begin{matrix}N.C_6H_5\\N.C_6H_5\end{matrix} + H_2S = CS\begin{matrix}NHC_6H_5\\NHC_6H_5.\end{matrix}$$

Further action takes place according to the following equation:—

$$CS\begin{matrix}NHC_6H_5\\NHC_6H_5\end{matrix} + H_2S = CS_2 + \underset{\text{Anilin.}}{2NH_2.C_6H_5}$$

Besides the products indicated in the equation, a very small quantity of α-triphenylguanidine was also found. When heated, α-triphenylguanidine is decomposed, thus:—

$$C\begin{matrix}=N.C_6H_5\\N.H.C_6H_5\\N.H.C_6H_5\end{matrix} = H_2NC_6H_5 + \underset{\text{Carbodiphenylimide.}}{C\begin{matrix}=N.C_6H_5\\N.C_6H_5\end{matrix}}$$

Carbon bisulphide and carbodiphenylimide yield phenyl mustard oil, according to the equation—

$$C\begin{matrix}N.C_6H_5\\N.C_6H_5\end{matrix} + CS_2 = 2C\begin{matrix}N.C_6H_5\\S.\end{matrix}$$

Various Communications.—Victor Meyer.

I. **Brombenzolsulphuric acid** and benzoldisulphuric acid yield, on the one hand, resorcin; on the other, terephtalic acid. But resorcin is a meta-compound, while terephtalic acid is a para-compound. To explain this anomaly, experiments were undertaken with the two benzol derivatives above mentioned. It was found that brombenzolsulphuric acid is a single substance, and not a mixture. A second sulpho-group was introduced into this acid, and a brombenzoldisulphuric acid thus obtained, which is not a mixture.

II. On the esters of **mercaptans.**—From thiophenol and acetyl chloride was obtained phenol thioacetate. Concentrated potassa resolves this substance into acetic acid and thiophenol.

III. **Dibromnitroethan** can be prepared readily and in a pure condition by mixing nitroethan with 2 mol. Br, pouring a little water upon the mixture, and now adding caustic potash until the color has disappeared.

Communications from the Laboratory of Göttingen University.—H. Hübner.

I. **Benzanilide** and **nitric acid.**—C. Stöver.

II. On isomeric **mononitrobenzonaphtylamides** and their different conduct towards hydrogen.—P. Ebell.—Two products are formed by the action of nitric acid on benzoylnaphtylamide.

III. On **benzoylamidophenoles.**—H. Morse.

IV. On **nitrosalicylic acid.**—L. B. Hall.—By the action of nitric acid on salicylic acid two isomeric mononitro products were obtained.

V. On **amidobenzonitriles.** — A. Fricke. — From metanitrobenzoyl chloride and paranitrobenzoyl chloride the corresponding benzonitriles were obtained.

Preliminary Notices.—Jul. Post.—Author intends to prepare all the possible varieties of **nitrosulphophenol,** and all the other nitro-derivatives of phenol, with the view of carefully comparing the corresponding members of the different series. In this paper he describes his results in connection with nitrosulphophenols.

Concerning the history of **fermentation** phenomena. —H. Struve.

The law of **multiple rotations.**—E. Mulder.

On **phloroglucic anhydride.**—H. Klasewitz.—This body, lately described by Piccard, was prepared by author nine years ago.

Detection of **alkaloids** in dead bodies.—W. Schwanert.—It appears that in bodies that have undergone decomposition there is present a substance with basic properties resembling an alkaloid, which is obtained in that stage of the examination in which coniine and nicotine would be looked for. The substance, however, whatever it is, cannot be mistaken for either of the mentioned alkaloids.

Ranite, a new mineral from Brewig.—S. R. Paykuller.—This mineral is allied to Thomsonite, and has the formula—

$$Al_2O_3.SiO_2 + \tfrac{2}{3}Na_2O.SiO_2 + 2H_2O\tfrac{1}{3}CaO.$$

No. 15.

On Siljeström's experiments on the change in **density of rarefied gases.**—D. Mendelejeff.—Siljeström has recently published the results of some experiments, by which he attempts to prove that air under decreased pressure (7 to 770 mm.) does not follow Mariotte's law, and that the variations are of the same kind as those already noticed for hydrogen under increased pressure (1 to 30 atmospheres). In this article the author calls attention to the fact that these experiments of Siljeström do not agree with those recently made by him, according to which the variations from Mariotte's law exhibited by gases under decreased pressure, take place in a direction opposite to that of the variations in gases

under increased pressure. If Mariotte's law is true, then, representing the pressure by P and the volume by V, we have PV = a constant, which we may call 1. If it is not true, then PV = 1 − a P, or PV = 1 + a P. It is shown that the first formula is true when the pressure is great, the latter when the pressure is decreased.

Remarks on the influence of **alkaloids** on certain properties of **hæmoglobin.**—Ed. Schaer.—From author's experiments it follows that the power of hæmoglobin to take up and transfer ozone is not weakened by the presence of alkaloids.

Communications from the Laboratory of Greisswald. —H. Limpricht.

I. **Sulphanilic acid** was prepared by heating anilin ethylsulphate—

$$\left.\begin{matrix}SO_2\\(C_6H_5NH_2)(C_2H_5)\end{matrix}\right\} O_2 = C_6H_4\left\{\begin{matrix}NH_2\\SO_3H\end{matrix}\right. + C_2H_6O.$$

This same principle was taken advantage of for the purpose of preparing other sulphoamido acids. Methylanilin-sulphuric acid and the corresponding diazo-compound are described. Further, the three fusible isomeric varieties of amidosulphobenzolic acid, viz., sulphanilic acid and two isomeric acids, prepared by reducing corresponding nitrosulphobenzolic acids. From these three acids were obtained three bromsulphobenzolic acids. All three of these substances, when fused with KOH, yield resorcin.

II. **Nitrobromsulphotoluic acid** was obtained by the action of nitric acid on orthobromparasulphotoluolic acid. When the corresponding amido-acid is treated with hydrogen, the bromine is eliminated, and a new amidosulphotoluolic acid is obtained—

$$C_6H_3\left\{\begin{matrix}CH_3\\SO_3H\\NH_2.\end{matrix}\right.$$

III. Experiments were made to determine the position of the nitro-group in the nitro derivatives of the sulphoacids of **ortho-** and **parabromtoluol.**

On isomeric **nitrotoluic acids, azotoluic acids,** and a second sulphocymotic acid.—F. Fittica.—Author shows that there are three intratoluic acids which are derived from paratoluic acid. According to the theory only two are possible. An explanation of the anomaly is attempted, but the suggested formulas are very complicated. From α- and β-nitrotoluic acids the same azo-acid is produced.

On the products of oxidation of **isobutylic alcohol.** —Ernst Schmidt.—A repetition of Wealmer's experiments showing that acetone is one of the normal products of the oxidation of isobutylic alcohol.

On **chrysene.** — Ernst Schmidt. — A repetition of Lieberman's work on the same subject, it being claimed that previous investigations were made with impure material.

On the **sulpho-acids of naphtylamine.** — Ernst Schmidt and Bern. Schaal.

On **diisopropylketone and methylisopropylketone.**—Rein. Münde.—The first of these bodies was obtained by dry distillation of pure calcic isobutyrate. By the action of hydrogen it is converted into secondary heptylic alcohol. Methylisopropylketone was prepared by the dry distillation of calcic isobutyrate and acetate. From this ketone also a secondary alcohol was obtained.

On **ortho-dinitrobenzol.**—A. Rinne and Th. Zincke. —This is formed together with the meta-compound by the action of nitric acid on benzol.

On **levulic acid** formed by the action of sulphuric acid on sugar.—A. Treikerr v. Geate and B. Tollens.—The acid has the composition $C_5H_8O_3$, and is formed according to the following equation:—

$$C_6H_{12}O_6 = C_5H_8O_3 + H_2O + CH_2O_2.$$

On the occurrence of **allylic alcohol** among the products of dry distillation of wood.—B. Aronheim.—Allylic alcohol was found in crude wood-spirits.

Concerning **cyanacetic acid.**—J. van't Hoff.

On the action of **ammonia on acetone.**—N. Sokoloff and P. Latschinoff.—By saturating acetone with ammonia and then adding oxalic acid and water, an acid oxalate of a base, diacetonehydramine, $C_6H_{13}NO$, is formed. Other salts of this base were also prepared. In the above reaction, further, two other bases are formed, viz., triacetonehydramine, $C_9H_{17}NO$, and triacetoneamine, $C_9H_{15}N$.

On some compounds of **mercuric sulphide.**—Karl Henmann.—When HgS is placed in water with Cu and the water boiled, a black product is obtained which consists of CuS, Cu, and metallic Hg. If this product is boiled with moderately concentrated nitric acid, the Hg and Cu are dissolved, while a dark powder remains behind which suddenly becomes white. If the white substance is then treated with alkalies, it turns black again, but it becomes white as before when boiled with nitric acid. It was found that the white substance is identical with the white precipitate which a small quantity of H_2S forms in a solution of mercuric nitrate, viz., $2HgS.Hg(NO_3)_2$. The blackening of this precipitate is caused by a separation of HgS.

Action of **cupric chloride on mercuric sulphide.** —Karl Henmann.—The two bodies combine, forming a compound—

$$\begin{matrix}Hg—S—Cu—Cl\\Hg—S—Cu—Cl,\end{matrix}$$

according to the equation—

$$3H_2S + 2CuCl_2 = Hg_2S_2Cu_2Cl_2 + HgCl_2 + S.$$

Communications from the Laboratory at Greisswald. —H. Limpricht.

On the connection between **substituted benzoles and phenoles.**—F. Beilstein and A. Kurbaton.—Parachloranilin was converted into the corresponding chlorphenol. From the latter dichlorbenzol was obtained which was identical with ordinary dichlorbenzol. Similar changes were effected in the ortho- and meta-series.

On derivatives of **methyldiphenylamine.** — R. Gnehm.—Bodies similar to those recently described by Austin were obtained by the action of nitric acid on methyldiphenylamine.

On the **diffusion of gases** through soap-bubbles.— F. C. G. Müller.—By placing soap-bubbles in hydrogen they became light and afterwards ascended.

On the action of **argentic oxide in ethyl bichlorpropionate.**—E. Klimenko.—Argentic acetate was obtained thus:—

$$C_3H_3Cl_2AgO_2 + 2Ag_2O + H_2O = C_3H_3AgO_4 + 2AgCl + Ag_2 + H_2O;$$

and $C_3H_3AgO_4 = C_2H_3AgO_2 + CO_2$.

Reply.—C. Liebermann.—Author claims, in opposition to E. Schmidt, that the chrysene with which he performed his experiments was pure.

Investigations on the synthesis of aromatic compounds by the abstraction of water.

IX. On the compounds of **monochloraldehyde** with aromatic hydrocarbons.—E. Hepp.—When diphenylmonochlorethan is boiled with alcoholic potassa, a hydrocarbon isomeric with stilbene is produced. This is diphenylethylene—

$$CH_2=C\begin{matrix}C_6H_5\\C_6H_5.\end{matrix}$$

By oxidation this substance is converted into benzophenone. Ditolylethylene was obtained by a method similar to that employed in the production of diphenylethylene. Diethylstilbene was produced by the dry distillation of diethylphenylmonochlorethan. It yields terephtalic acid when oxidized. Monochloraldehyde and xylol yield a product which, when subjected to dry distillation, gives rise to the formation of tetramethylstilbene—

$$\begin{matrix} HC—C_6H_3(CH_3)_2 \\ \| \\ HC—C_6H_3(CH_3)_2, \end{matrix}$$

isomeric with diethylstilbene, together with another compound probably of the same composition. By oxidation tetramethylstilbene yields xylylic acid. Monochloraldehyde and chlorbenzol yield dichlordiphenylethylene—

$$CH_2=C\begin{matrix} C_6H_4Cl \\ C_6H_4Cl. \end{matrix}$$

Monochloraldehyde and naphtalin give

$$\begin{matrix} CH.C_{10}H_7 \\ \| \\ CH.C_{10}H_7. \end{matrix}$$

X. On the compound of **crotonchloral and benzol.**—E. Hepp.—The following equation describes the reaction:—

$$C_3H_2Cl_3.CHO + 2C_6H_6 = C_3H_2Cl_3.CH(C_6H_5)_2 + H_2O.$$

The product is called diphenylbichlorquartene.

On **alcohol fermentation.**—Fr. Mohr.—Attention is called to older experiments which prove that oxygen is not necessary for the growth of yeast-cells; whereas Brefeld recently asserted that the cells can not grow without oxygen.

On **worm-seed oil and cymene.**—A. Faust and J. Homeyer.—The oil consists essentially of one body, which was separated and analyzed, though no formula was deduced from the results. Cymene was prepared by treating the oil with P_2O_5. It was found to be identical with cymol.

On **eucalyptus oil.**—A. Faust and J. Homeyer.—This oil consists of two terpenes, cymol and a body containing oxygen that bears a close relation to cymol.

Condensation of higher **ketones.**—Oscar Jacobsen.—By treating a mixture of acetone and methylethylketone with sulphuric acid, dimethylethylbenzol was obtained. Substitution-products of this new hydrocarbon were prepared. As a second product of the above reaction, triethylbenzol was obtained.

Concerning **molecular rearrangement in the aromatic series.**—Eugen Demole.—It was found that Lauutemann's oxysalicylic acid is a mixture of protocatechuic acid and oxysalicylic acid. Absolutely pure oxysalicylic acid when distilled gives either hydroquinone alone, or a mixture of this body with hyrocatechin. Pure diiodosalicylic acid when melted with KOH yields both oxysalicylic acid and protocatechuic acid.

No. 16.

On the occurrence of a ferment in **vetch seeds.**—v. Gorup Besanez.—The ferment was extracted by means of glycerin. It has the power to convert starch into sugar, and albuminous substances into peptones.

Reduction of **benzophenone.**—W. Staedel.—Author obtained diphenylmethan by gently heating an intimate mixture of powdered benzophenone and zinc-dust.

Oxidation of ammonia by ozone.—L. Carius.—The oxidation takes place according to the following equations:—

$$(NH_3)_2 + (O_3)_4 = N(NH_4)O_2 + O_2H_2 + (O_2)_4$$
$$N(NH_4)O_2 + O_2H_2 = N(NH_4)O_3 + OH_2.$$

The presence of hydrogen peroxide, and nitrous and nitric acid in nature is due to this process.

On the deterioration of **color of cinnabar,** caused by contact with copper and brass.—Karl Heumann.—The change in color is due to the formation of cupric sulphide, the sulphur being taken from the cinnabar.

On chlorinated **phenyl mustard oil** and its derivatives.—F. Beilstein and Ap. Kurbatow.—Dichlorphenylsulpho-urea $CS(N.C_6H_4Cl.H)_2$ was produced from chloranilin by treatment with CS_2 and alcohol. From this the corresponding mustard oil was prepared by treating the boiling alcoholic solution with iodine. From the mustard oil, by treating with copper, a nitrite was obtained which yielded chlorbenzoic acid. The chloranilin which formed the starting point of the transformations belonged to the para-series, and the chlorbenzoic acid finally obtained belonged to the same series.

On the **alkaloid substance in dead bodies.**—Ad. Dupré.—The substance recently mentioned by writers as occurring in bodies examined by them for poison, was described by author in 1866. The most characteristic property of the substance is the fluorescence of its solutions.

Communications on **crude and pure wood-spirits.**—M. Grodzhi and G. Kræmer.—Three products have been found in crude wood-spirits, viz., acetone, methyl acetate, and methylic alcohol. Authors have further found allylic alcohol in very small quantity.

Notice on the preparation of gaseous **iodhydric acid.**—A. Baunon.—Amorphous phosphorus is placed in a retort, and a solution of two parts iodine in one part iodhydric acid (sp. gr. 1·7) allowed to drop upon it through a funnel-tube. A constant and regular evolution of iodhydric acid gas is obtained.

On an interesting **oxidation of metallic aluminum.**—Carl Jehu and H. Hinze.—The metal was rubbed upon soft leather, which was impregnated with mercury. The rubbed surface became warm and soon became covered with Al_2O_3.

Action of **bromine on aldehyde.**—A. Punier.—Paraldehyde was diluted with acetic ether, and bromine then slowly dropped into it. The products were bibromaldehyde and bromal. The former combines with cyanhydric acid, and the compound on being treated with HCl yields bibromlactic acid. Bromal also combines with cyanhydric acid, and the resulting compound yields tribromlactic acid.

Notice on **orthobrombenzoic acid.**—Th. Zincke.—The acid was obtained by oxidizing orthobromtoluol with nitric acid.

On the action of reducing agents on **benzonitranilin and benzonitrotoluidin.**—C. A. Bell.—From benzonitranilin there was obtained a base benzoyltoluylendiamine—

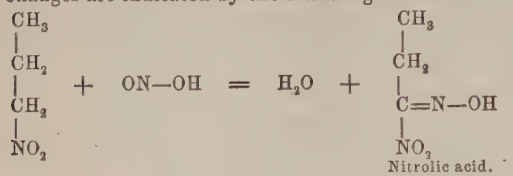
$$\left.\begin{matrix} C_6H_4 \\ C_7H_5O \\ H_3 \end{matrix}\right\} N_2,$$

from which the oxygen could not be eliminated without decomposition. The experiments with benzonitrotoluidin led to similar results.

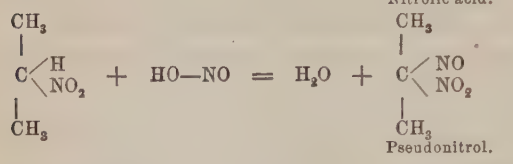
Diagnosis of **primary, secondary, and tertiary alcohols** by color-reactions.—Victor Meyer and J. Locker.—If it is required to decide whether an iodide of the series $C_nH_{2n+1}I$ contains a primary, secondary, or tertiary radical, it is only necessary to distil it with argentic nitrite and to treat the distillate with potassa and nitrous acid. If the mixture turns *red* (formation of nitrolic acid) the radical is primary; if it turns *blue*, (formation of pseudonitrol) the radical is secondary; and if there is no change of color the radical is tertiary.

A very small quantity of the iodide (0·3 to 0·5 gr.) suffices for the test.

On **pseudonitroles.**—Victor Meyer and J. Locker.—It is shown, that, while primary nitro-substances yield nitrolic acids by the action of nitrous acids, the secondary nitro-substances yield products entirely different from the nitrolic acids, called pseudonitroles. These changes are indicated by the following formulas :—



Nitrolic acid.



Pseudonitrol.

On **ethyltoluol.**—Paul Jannasch and A. Diechmann.—The hydrocarbon was prepared in the usual way from parabromtoluol, ethyl iodide, and sodium. It yields two isomeric dinitro-compounds when treated with nitric acid. Further treated with nitro-sulphuric acid, both of these dinitro-compounds yield the same trinitro-compound.

The **reduction of metallic oxides by hydrogen,** and the employment of this reduction for the separation and quantitative estimation of the metals.—W. Müller.—Among other results (mostly negative) reached is this, that, when oxides are precipitated together from a solution, they are present in an uncombined state.

On the use for photographic purposes of the **light from nitric oxide and bisulphide of carbon.**—Eug. Sell.—Author has constructed a lamp in which bisulphide of carbon and nitric acid are caused to act together in giving a constant flame. This light has been employed with success for the purpose of taking photographs. I. R.

Journal für praktische Chemie.

Nos. 17 and 18, 1874.

On the **imperfect combustion of gases** and mixtures of gases, and of the action of chemical affinity thereby disclosed.—E. von Meyer.—This article does not admit of useful abstraction.

Note on the **antiseptic action of salacylic acid.** W. Knop.—Free salicylic acid exerts a marked influence in retarding plant life, but the action ceases as soon as the acid becomes neutralized by ammonia set free through decomposition of the albuminous bodies.

On **North American tellurium and bismuth minerals.**—F. A. Genth.—Communicated by the author at a meeting of the American Philosophical Society, August 21, 1874. The author sums up the recent discoveries of tellurium minerals in Colorado, North Carolina, and Montana, and describes the following varieties, some of which had been previously examined by Prof. Silliman. Native tellurium, tetradymite, altaite, hessite, petzite, sylvanite, calaverite, tellurate of copper and lead (a new mineral), and schirmerite (a new mineral). He criticizes Dr. Endlich's analyses recently published in the American Chemist, claiming that they were made on impure material.

On the **spectrum analysis of colored liquids,** glasses, and vapors. Second Part.—W. Stein.—Since the character of these spectra is independent of the chemical substance, they are valueless for identifying bodies. Picric acid, potassium ferrocyanide, uranic acetate, neutral potassium chromate, phosphomolybdic acid, all give the same spectra.

No. 20.

Chemical retrospect for the year 1873.—H. Kolbe.—This consists mainly of a personal attack on the *Deutsche Chemische Gesellschaft zu Berlin*, which, the writer claims, has no right to the name *Deutsche*.

In memory of **Ludwig Glutz.**—H. Kolbe.—Dr. Glutz was Prof. Kolbe's first assistant in the University Laboratory of Leipzig.

In memory of **Justus von Liebig.**—H. Kolbe.—Liebig's Relations to Agriculture, by Prof. Stohmann; Liebig's Relations to Zoo-chemistry, by Prof. Neubauer. These three papers, eulogistic of Liebig and his labors in various fields of research, are not suitable for abstraction. H. C. B.

Sitzungsberichte der mathematisch-physikalischen classe der königliche bayeresche Academie der Wissenchaften zu München. Parts III., 1873; I. and II., 1874.

On **Tschermakite,** a new mineral of the feldspar group.—von Kobell.—This mineral accompanies Kjerulfite in Bamle, Norway. It is grayish-white in color, translucent to transparent, has a glassy lustre, and on fresh surfaces a diamond lustre. H. = 6; sp. gr. 2·64. The mineral phosphoresces on warming. B. B. melts quietly and yields, in a tube, water. Attacked with difficulty by acids. Composition $3\dot{R}\ddot{S}i_2^3 + \ddot{A}l\ddot{S}i_2$. Analysis :—

Silica	66·57
Alumina	15·80
Magnesia	8·00
Soda	6·80
Potash	trace
Water	2·70
	99·87

The mineral consequently approaches in nature a magnesia oligoclase, but is distinguished from it by total absence of lime.

On certain derivatives of sulphurea.—J. Volhard.

I. On **sulphocyan-acetic acid.**—Glycolylsulphurea, formed by the action of monochloracetic acid on sulphurea, decomposes with great facility on heating with any acid in aqueous solution.

$$\left.\begin{matrix}CH_2.NH\\CO.NH\end{matrix}\right\}CS + HCl + H_2O = H_4NCl + \left\{\begin{matrix}CH_2.NCS\\CO.OH.\end{matrix}\right.$$

The resulting body, sulphocyanacetic acid, is characterized by the facility with which it crystallizes from a warm solution. A more convenient method of preparation is to heat monochloracetic acid with sulphurea and water on a water-bath.

II. **Sulphurea.**—The author describes the method for preparing sulphurea, and shows what precautions are necessary to obtain a good yield. For details we must refer to the original. The solubility of argentic chloride in sulphurea leads to speculations as to its possible usefulness in photography.

III. **Guanidine.**—The concentrated mother liquid from the preparation of sulphurea yielded, by appropriate treatment, guanidine. This led to further experiments, and the author claims to have found the best and cheapest method for procuring guanidine as yet discovered.

IV. **Cyanamide.**—The preparation of this body is best effected by acting on sulphurea with red mercuric

oxide in presence of water. Mercuric sulphide settles and admits of washing. To prevent decomposition of the cyanamide solution on evaporation of the filtrate, a few drops of acetic acid are added, and then agitated with ether.

V. **Melam.**—A new light is thrown by these researches on the remarkable products of decomposition of ammonium sulphocyanide, long since discovered by Liebig. Melam is evidently a product of the decomposition of guanidine sulphocyanide.

On the preparation of **methylic ether.**—Prof. Erlenmeyer.—Since the employment of methylic ether in ice-machines it is made on a large scale. The following method is the best: Heat to 140°, in a flask connected with an inverted condenser, a mixture of 1·3 parts methylic alcohol and 2 parts sulphuric acid. The gas is purified from sulphurous anhydride by passing through sodium hydrate, and conducted into sulphuric acid kept cool by being surrounded with cold water. 1 volume sulphuric acid absorbs 600 volumes methylic ether. This solution keeps well, and the ether may be liberated by mixing the solution with water.

On a new method for the **titration of silver.**—J. Volhard.—On adding a solution of ammonia sulphocyanide to an acid argentic solution containing ferric sulphate, each drop of the ammonium sulphocyanide causes a blood-red coloration, which immediately disappears with formation of a milky-white precipitate of argentic sulphocyanide. As soon as all the silver is precipitated, the red color of the ferric sulphocyanide becomes permanent. Upon these reactions the author bases a general method for the titration of silver, which appears to possess delicacy and accuracy.

On **chrysotil, antigorite, and marmolite,** with their relations to olivine.—Von Kobell.

Chrysotil has the composition $\dot{M}g\dot{H}_2 + 2\ g\dot{S}i$.

Antigorite has the composition $\dot{M}g\dot{H}_2 + 2\dot{M}g\dot{S}i$.

Marmolite has the composition $2\dot{M}g\dot{H}_2 + 3\dot{M}g\dot{S}i$.

The chemical relations between these three and their relations to olivine are studied at some length.

On the relative **constitution of diazo-compounds.**—Prof. Erlenmeyer.—The author presents theoretical views of the constitution of the diazocompounds, discovered by Peter Griess in 1858, which are at variance with those of Kekulé, and others generally adopted.

He considers the diazo-bodies as ammonium compounds of the general formula—

$$R—N—R'$$
$$\quad\quad N$$

For example, diazobenzol nitrate he considers related to aniline nitrate as represented in the following formulas—

$$\begin{array}{l} C_6H_5 \\ | \\ N—O—NO_2 \\ \| \\ H_2 \end{array}$$

Aniline nitrate.

$$\begin{array}{l} C_6H_5 \\ | \\ N—O—NO_2 \\ \| \\ N \end{array}$$

Diazobenzol nitrate.

Observations on **ozone in the atmosphere of the Libyan Desert.**—Prof. Zittel.—As a result of simultaneous observations in the desert and in certain oases (Dachel, etc.), conducted between January and April, the author concludes that ozone exists in far greater quantity in the desert than in the regions abounding in vegetation and water.

H. C. B.

Annalen der Physik und Chemie, von J. C. Poggendorff.

No. 4, 1874.

On the **light reflected from potassic permanganates.**—E. Wiedemann.

Apparatus for **preparing and burning explosible gases** without danger.—A. Gawalowski.

Automatic **rinsing apparatus.**—A. Gawalowski.

Desiccator for dehydrating in rarefied chamber, without application of the air-pump, by the same.

Filtration with pressure, by the same.

This and the three preceding are descriptions of forms of apparatus, which would be incomplete and unintelligible without the accompanying figures.

The absolute **zero point of heat.**—Von Koppe.

Remarks on **Zollner's Work. Photometrical researches.**—J. W. Berg.

No. 5.

Mineralogical communications.—G. v. Ruth.—13th paper, containing—

75. A new contribution to our knowledge of the crystallization and the twinning of tridymite.

76. A calc spar twin from the upper lake, from the collection at Castle Schaumburg.

77. Noticeable growth of rutile and specular iron.

78. Extraordinary crystals of artificially prepared metallic copper.

79. Hypersthene of Mont. Dore in Auvergne, discovered by Descloiseaux.

80. Foresite, a new zeolite mineral, from the granite ledges of the Island of Elba.

Observations.—1. Audezine from the Trachyte of the highlands of Equador.

2. Crystalline form of the cordierite of Laach.

3. Yellow augite from Vesuvius.

On the **crystalline form and the modifications of Selenium.**—C. Rammelsberg.—Four modifications are recognized, the description and specific gravities of which are given as follows:—

	Sp. gr.	With CS_2.
1. Amorphous,	4·3	Red, soluble.
2. Crystallized,	4·5	Red, soluble.
3. Granular,	4·4 to 4·5	Gray, insoluble.
4. Laminated,	4·8	Almost black, insoluble.

The crystallography of the crystalline forms is discussed.

Spectroscope with fluorescing eyepiece.—J. S. Loret.

Alteration of ordinary phosphorus into amorphous by action of electricity.—Geissler.

Lightning spectra.—T. Hoh.

No. 6.

Communications from the Mineralogical Institute of the University of Strasburg.

1. On the crystalline form and the thermo-electrical properties of gray cobalt.—P. Groth.

2. On the chemical composition of leadhillite.—C. Hintze.

3. Crystallographic researches on the combinations of aldehyd with aromatic hydrocarbons, by the same.

4. On an increase in twinning of Willimite.—A. Arzonni.

5. Optical researches on terpentine oil hydrate, by the same.

6. Crystallographic and optical researches on a body allied to urea, by the same.

7. On two isomorphous benzolderivatives, by the same.

On **diffusion between dry and moist air.**—E. Rensch.

No. 7.

Notice on the action of **cuprous sulphide on a solution of argentic nitrate.**—R. Schneider.—The reaction was proved to be $Cu_2S + 4AgNO_3 = Ag_2S + Cu(NO_3)_2 + 2Ag$. E. W.

Les Comptes Rendus de l'Academie des Sciences.

Vol. lxxix., No. 12.

Note on **basic sulpho-carbonate.**—M. P. Thenard.—This substance has been much used, at the suggestion of M. Dumas, for the destruction of phylloxera, so that considerable interest has been taken in the methods of producing it.

To prepare it on the small scale it is only necessary to add carbon disulphide to a dilute solution of baric sulphide, when the sulpho-carbonate is precipitated as a dense brown crystalline powder, which is purified by washing out excess of CS_2 by alcohol, and evaporating to dryness.

On the large scale, however, its preparation is not so simple. It consists of four parts—

1st. Adding to the mother liquor of baric sulpho-carbonate resulting from former preparations of the substance, hot concentrated sulphite of barium, allowing the temperature to rise from 15° or 18° to not higher than 40°.

2d. Having poured off a certain quantity of this mixture, adding a little less carbon disulphide than it can absorb, agitating vigorously for five or six hours, and then pouring it into a vessel in which the solid sulpho-carbonate is allowed to accumulate. This settles very quickly, and at the end of 24 hours the supernatant liquid is poured off.

3d. The decanted liquid is treated with a large excess of carbon disulphide, and the agitation this time continued 12 or 15 hours. As the sulphide of barium remains in excess in the liquid, a fresh quantity of sulpho-carbonate is thus obtained. This is treated as above, taking care not to pour off carbon disulphide with sulpho-carbonate in suspension. This forms the liquid of (1).

4th. The mother liquor, having been decanted, is replaced by the liquid of operation (1), agitated as in (2), etc., proceeding from operation (4) to (3), and (3) to (4) indefinitely.

Hitherto the most concentrated solutions have not begun to crystallize till about 70°, the temperature being over 80° on separation from the filtrate.

Result of Analysis.

Dry sulpho-carbonate of barium,	389 gr. per litre.
Baryta of the mother liquor . .	27 " "
Dry sulpho-carbonate represented by this baryta	41 " "

Making the loss only 10 per cent., even without utilizing the mother liquor, as can be done. For use, however, it would seem advisable to transform it into potassic sulpho-carbonate, which is more soluble, and less injurious to vegetation. This is now being attempted

The above loss is exaggerated, for not over 15 of the 41 gr. baryta is in the state of sulpho-carbonate.

The action of **liquid medicine or food on tin vessels containing lead.**—M. Fordos.—The author has examined various alloys of tin and lead used for drinking and culinary purposes, containing generally about ten per cent. of lead.

1st. He introduced, into the covered tin pots used by the pharmacists, water acidulated with one per cent. crystallized acetic acid. After some days the walls of the vessels were covered with a light white deposit, soluble in the acidulated water, and giving to it the reactions of a plumbic solution. Moistened paper rubbed on the walls of the vessels turned yellow with potassic iodide, and lastly in some experiments needle-shaped crystals of a lead salt, evidently the acetate, were observed. Wine and vinegar placed in the same vessels also were found to contain lead.

2d. Red wine was placed in two tin goblets, one new, the other old. After twenty-four hours, it gave an appreciable amount of lead in both cases.

3d. Lemonade, after standing twenty-four hours in one of these tin pots, has been found to contain lead.

These experiments, which will be continued, would seem to show that there is serious danger in the use of these tin vessels containing lead.

Researches on the **coloring matters of the madder.**—A. Rosenstiehl.—(Extract by the author.)—Since the publication (1864) of the work of MM. Schutzenberger and Schiffert, on commercial purpurine, four coloring matters have been found to exist in madder: alizarine, pseudopurpurine, purpurine, and a hydrate of the last. In preparing and experimenting upon them, the author has found that the last two are formed at the expense of pseudopurpurine.

He has also studied the products of the reduction of purpurine, and reproduced it from these, and finally obtained two isomers of purpurine, one of which is very much like it in its coloring properties, and has been obtained by synthesis from benzoic acid.

1st. Alizarine as prepared by the processes laid down, is not pure. After sublimation it should be crystallized from alcohol a great number of times, till the tint given by two successive mother liquors is the same. To shorten this process the author heats commercial alizarine some hours at 200° C., with water and a small quantity of caustic alkali. Foreign substances are thus totally destroyed, and the alizarine purified by crystallization.

Pure alizarine dissolved in distilled water dyes mordanted tissue very imperfectly. It is necessary to add an aqueous solution of carbonate of lime, enough to form monocalcic alizarate. A larger quantity forms a bicalcic lake which does not dye.

With alizarine thus prepared, a deeper violet is obtained with alumina mordants, than by alizarine prepared in the common way (circle ω or I of Chevreul's chromatic circles)—very different from "red madder." With iron mordants a very fast and delicate violet-blue is obtained, which distinguishes alizarine from the other coloring matters of the madder.

2d. Pseudopurpurine, discovered by MM. Schutzenberger and Schiffert, constitutes, with alizarine, the greater part of the coloring matter of madder. It only dyes in distilled water. Iron mordants give tints much like those of alizarine. These, unlike the other madder colors, are much injured by washing with soap. Pseudopurpurine is very unstable, is decomposed by boiling alcohol or distilled water, and changes into a mixture of purpurine and its hydrate. Pseudopurpurine has the formula $C_{14}H_8O_6$ and purpurine $C_{14}H_8O_5$ showing that the water and alcohol exercise a reducing action.

There is also formed a little purpuroxanthine $C_{14}H_8O_4$, an isomer of alizarine.

This remarkable reaction takes place below 100°.

3d. In accordance with the above, pseudopurpurine cannot exist in the commercial products of the madder which have been treated with hot acidulated water.

As it forms an insoluble calcic lake so readily, and is so unstable, it is of little use in dyeing, except when transformed into purpurine.

4th. Purpurine dyes easily in distilled water. An

amount of carbonate of lime, corresponding to a monocalcic lake, does not injure it, but the insoluble tricalcic lake does not dye, and is decomposed by carbonic acid with extreme slowness.

The shades obtained with purpurine are very different from the preceding. The colors are not stable.

5th. Hydrated purpurine has been obtained, by precipitation from a solution of purpurine, in an alkali or alum water, with an acid.

With lime-water, its action is like that of purpurine. The red and rose tints of these two are as fast as those of alizarine, but do not withstand the action of the sun as well.

6th. The finest red and rose tints cannot be produced by alizarine alone. The presence of purpurine or its hydrate is indispensable.

7th. In treating pseudopurpurine and purpurine with various reducing agents, alizarine has never been obtained. Its isomer purpuroxanthine has been obtained, and this will be hereafter considered.

These results confirm those of M. Schutzenberger. It is doubtful whether purpurine can be changed into alizarine by heat, though a mixture of alizarine and purpurine, in which the latter predominates, may give shades much like pure purpurine, and then by the action of heat the whole or part of the purpurine may be destroyed, and the presence of the alizarine then first recognized.

New experiments on the principal **sulphur waters of Luchon.**—F. Garrigon.—The author has shown the existence of a sulphydrate of an alkaline sulphide in these springs (Am. Chem., Feb., p.). This was objected to by M. Filhol, and the author now refers to some points in which he regards M. Filhol as in error.

1st. In determining free carbonic acid in a *warm* sulphurous water, it should not be filtered as M. Filhol has done, as an appreciable quantity of carbonic acid is likely to be lost. It should simply be decanted with a siphon.

Determined in this latter way (Sept. 19), this water furnished 0·0320 gr. per litre total carbonic acid, while by this method of filtration only 0·0238 gr. was obtained under the same conditions.

2d. It is certain then that this water contains carbonic acid either free or combined, while M. Filhol claims that there is none, or at least only traces.

The author claims that after treatment of these waters with carbonate of lead, carbonic acid is set free, as there is an equal quantity of sulphydric acid present. Moreover on boiling they act like solutions of sulphydrates, giving off as much as 10 c. c. at least of sulphydric acid per litre.

The author claims that these waters, *completely* desulphurated by *perfectly neutral* sulphate of lead, become acid, whereas M. Filhol finds them slightly alkaline. The acidity is owing to sulphuric acid set free by the sulphydric acid, and (19th Sept. 1874), this water furnished 0·0085 gr. sulphuric acid when desulphurated by nitrate of silver, whereas with *perfectly neutral* sulphate of lead it gave 0·1156 gr. sulphuric acid. 1071 gr. result then from the transformation of sulphides. We have been able to calculate, by the weight of total sulphur (0·0294 per litre), that it would give 0·717 gr. of monosulphide of sodium. This represents 0·0569 gr. soda, which requires 0·0753 gr. sulphuric acid. We have left then 0·0338 gr. sulphuric acid, which can only be attributed to sulphydric acid, either free or combined, and corresponds to 0·0143 gr. of it, so that the author concludes that these waters contain a sulphydrate and not a monosulphide.

Note on **warwickite.**—J. Lawrence Smith.—Several years ago, when at work with Prof. Brush on American minerals, the author pointed out the fact that warwickite had a definite composition totally different from what had been assigned to it. It was described as a new species by Prof. Shepard (*Amer. Journ. Sc.*, vols. xxxiv. and xxxvi., 1838–9). Two varieties have been confounded, one pure, the other having the same crystalline form, but containing only a very little true warwickite. Afterward Prof. S. Hunt called the impure variety *enceladite*, and assigned to it the composition: titanic acid 31·5, magnesia 43·5, ferric oxide 8·1, loss on ignition 2·0—total, 85·1. Fifteen per cent. was lost by an accident to the analysis, and further investigation showed that he had not worked on the pure mineral. It was found that warwickite contained 20 per cent. boracic acid (*Amer. Journ. Sc.*, xvi. 293). Its density is 3·35 (Brush and Smith, *Comptes Rendus*, lxxix. 12); 2·355 (Damour).

It has an easy longitudinal cleavage, the cleavage surfaces having a characteristic metalloid appearance. The author finds its composition to be as follows:—

		Oxygen.	Ratio.
Boracic acid . . .	27·80	19·06	·9
Titanic acid . . .	23·82	10·37	·5
Magnesia . . .	36·80	14·46	·6
Ferric oxide . . .	7·02	2·10	·1
Silica	1·00		
Alumina	2·21		

Silica and alumina are impurities, the latter from spinel, which it is difficult to separate out completely.

Confirmed by other partial analyses, the composition of the mineral seems to be—

3 B̈ . . .	105	30·57	per cent.
2 Si . . .	81	23·58	"
6 Mg . . .	121·44	35·36	"
Fe . . .	36	10·49	"
Total,	343·44	100·00	"

It is rather difficult to give the exact formula of warwickite; it may be represented as follows:—

$$Mg_5\ddot{B}_3 + (Mg,Fe)Si_3.$$

It is the only known borotitanate. In the same locality is found a titaniferous iron, containing, according to Rammelsberg's analysis, about 15 per cent. of magnesia.

The part performed by **gases in the coagulation of the blood.**—E. Mathieu and V. Urbain—Part II.—Giving the results of a long course of experiments, not suitable for abstraction, establishing a relation between the formation of fibrinous clots and the accumulation of carbonic acid in the blood, or alteration of the organs whose office it is to eliminate it. J. M. M.

Archiv du Pharmacie.

January, 1874.

Testing magnesium sulphate for alkali.—E. Biltz.—The method of the German Pharmacopœia for testing Epsom salts for alkali, is to boil a given weight of the salt with three times its weight of barium carbonate, filter, and test the filtrate with test-paper for alkali. It is objected that in the process more or less magnesium bicarbonate (probably basic magnesium carbonate, or magnesium hydroxide) is formed, which passes into solution, and renders it alkaline. To obviate this difficulty the following method is suggested: Two grammes of dry calcium hydroxide are ground with two grammes of magnesium sulphate to be tested, and a few drops of water added to render the whole a moist powder. Then five grammes of a mixture of equal parts of water and alcohol of 90° are added, the mixture shaken occasionally for an hour, and finally ten grammes of abso-

lute alcohol added, vigorously shaken, and the whole set away to settle. After the liquid has become clear, a piece of turmeric paper is introduced; if the color remains unchanged, the salt is free from alkali.

Calcined magnesia.—Sarrazin.—The following is recommended as a good method of preparing MgO: A cast-iron pot of 8 or 10 litres capacity, with a sheet-iron cover so constructed that half of it can be opened or closed at pleasure, is placed so as to be easily heated. Through the centre of the cover a stirrer is inserted, with arms very much after the style of a coffee-burner. The pot is filled about three-quarters full of dry-sieved $MgCO_3$, and heated. At first water escapes, when the cover, or half of it, should be open. After the water is expelled, the cover should be closed, the heat raised, and the mass stirred until a portion of it, tested, is found free from CO_2.

February.

Pareira brava.—D. Hanbury.—A Brazilian plant, whose root is of great medicinal value. Several other plants from the same country resemble it, and are often sold for it, particularly Cissampelos Pareira. From its history, as well as from certain genuine specimens of the plant in the British Museum, the author thinks the true Pareira brava (Portuguese name) is the botanical Chondodendron tomentosum, and was very accurately described to the French Academy, in 1710, by M. Etienne Francois Geoffroy, Professor of Medicine in the College of France. According to this description the root is of a woody, hard nature, externally of a dark color, and internally of a dark-yellow color. A transverse section discloses several concentric rings, intersected by numerous fibrous rays running from the axis to the periphery. It has no smell, but a sweetish-bitter taste. Usually from ½ to 1½ inch in diameter. An excellent diuretic.

Volumetric estimation of sulphuric acid and of Cl as a means of estimating the quantity of fixed alkali. —E. Bohlig.—The principle of the method is, that an alkaline sulphate is converted into the corresponding carbonate by barium carbonate in water, containing free CO_2 at from 50° to 60° C. After filtering, the alkali can be determined by a normal acid.

Again, a chloride of a fixed alkali in solution is readily converted into the corresponding carbonate by digesting a short time with silver carbonate. After filtering, the alkali can be estimated, as before, by a normal acid.

Chemical examinations of slates near Lehesten in Thueringen.—F. B. Bischoff.—Theoretical views of the origin and age of the roofing slates near Lehesten, based on the results of their chemical analysis by Dr. Maeder.

Nephrite, jade, and saussurite in the Kuenlun range of mountains.—Hermann von Schlagintweit-Sakuenluenski.—Nephrite, according to the writer, occurs chiefly at Khotan in the above-mentioned range of mountains in upper Asia, associated with jade and saussurite. It is found sometimes in layers from 20 to 40 feet thick, with gneiss above and below it. In eastern Turkestan, nephrite with its allied minerals bears the name yashim or yashm, of Persian origin. In India it is also called yashim, and in China yu, which in German, French, and English is transformed into jade. The Greek word nephrite signifies kidneystone, and refers to the practice of wearing it near the body in the middle ages as a preventive or antidote to kidney difficulties.

Nephrite, jade, and saussurite are all anhydrous silicates, the first being a lime-magnesia silicate, while the others are alumina-soda and alumina-lime silicates respectively. The color of all these minerals is variable, the prevailing one being a grayish-green with a milky turbidity. A clear, pure green is valued most highly. These minerals after being taken from the quarry increase greatly in hardness, and then take a fine polish. They are used, especially in China, for making ornamental articles, idols, historical statuettes and groups, fantastic figures of animals, dishes, vases, etc.

Reaction of **calcium sulphate and iron carbonate** in mineral water.—L. F. Caro.—Certain experiments lead to the inference that calcium sulphate and iron carbonate undergo, to a certain extent, mutual decomposition in mineral water, and that this decomposition is dependent within certain limits on increased temperature. In this way the author accounts for the stronger iron taste of some mineral water when heated, as, for instance, the Pyrmont water.

New cut-off for a burette.—E. Mylins.—In place of the common quetschhahn the insertion of a short glass rod of the proper size in the rubber tube is recommended as very convenient. The simple pressure of the tube about the rod by the thumb and forefinger produces a fold sufficient to allow the solution to flow, while removal of the pressure closes the tube completely.

March.

Changes in spring and river water at different seasons of the year.—E. Beichardt.—Discussion of the differences of spring, river, and well water, as related to health, based on results of chemical analyses of these different kinds of water used in the city of Jena. The conclusion is that neither the water of rivers nor that of wells in cities contaminated by the constant influx of impurities is promotive of health. Mountain spring water is in every respect most desirable, and should be obtained whenever possible.

Recent investigations on the species and home of the **genuine rhubarbs.**—E. Langethal.—The rhubarbs appear to be indigenous to upper Asia, where they grow in the valleys and on the steppes of Thibet from 8000 to 10,000 feet above the sea, between 35° and 40° north latitude, and as far east as the Chinese wall. The Russian rhubarb and the Chinese are probably the same species and come from the same country, the names being due to the places of export, Kiachta and Canton, whither they are carried by caravans. Several species of rheum (palmatum, undulatum, cruentum, emodi or australe) have in succession enjoyed the reputation of being the best; but there is reason to believe that the best kind does not reach us, since the Chinese are said not to export it. The rhubarb plants in the garden of the Medical Faculty, Paris, in the Kew botanical garden, in the garden of Dr. Hanbury, London, and in that of Mr. Ulster at Bodicott, Oxfordshire, as well as in that of the Pharmaceutical Society, Strassburg, have descended from two buds from roots sent to Paris by Mr. Dabry, who lately travelled in Thibet, and is said to have obtained roots of the genuine plant. It is the so-called rheum officinale, and is different from any hitherto known species. Whether the roots when sufficiently mature will be found of medicinal value is yet uncertain.

Collecting **gum Senegal in Senegambia.**—Dr. B. Férand.—Several species of Acacia (Arabica, Seyal, Verek, and Adansonii) produce gum Senegal. These trees grow in the districts of Sahara, and are cultivated by the natives, who have very strict rules in respect to gathering the gum. The annual quantity of it sent to market is not far from 3,000,000 kilos.

A. P. S. S.

Journal de Pharmacie et de Chemie.

November, 1874.

On the **role of gases in the coagulation of blood.**—E. Mathieu and V. Urbain.—The result of experiments shows, 1st, that carbonic acid is the agent of the spontaneous coagulation of the blood; 2d, that during life the obstacle to this coagulation exists in the blood corpuscles, these having for their special function the fixation not only of oxygen, but also of carbonic acid contained in the blood.

Note on **chlorophyll.**—M. Filhol.—On adding a very small amount of hydrochloric acid to a solution of chlorophyll, the green color disappears and a turbidity ensues, a substance nearly black being deposited. Dicotyledonous plants yielded an amorphous black substance in this way, while that obtained from the chlorophyll of monocotyledonous plants was always crystallizable. They are soluble in hot, but insoluble in cold alcohol; also in cold ether, benzene, chloroform, carbon disulphide, and glacial acetic acid. The solutions in the last four differ very much from one another, but are all fluorescent. They all lose color in sunlight, though with different degrees of rapidity according to the solvent. Concentrated hydrochloric or sulphuric acids dissolve the crystals slowly, giving solutions entirely without fluorescence.

Note on the **production of oxamic acid** by the oxidation of glycocol.—R. Engel.—On treating glycocol with potassic carbonate, oxalate and oxamate were found to have been formed; some other products were also formed which the author proposes to investigate.

On the action of **sunlight on potassic iodide.**—M. Vidan.

On a **new reaction of essence of mint.**—Dr. C. Roucher.—On adding to acetic acid of 10° one-twentieth of its weight of essence of mint, a blue coloration makes its appearance in the course of about an hour, a peculiar dichroism being observable, the solution being blue by transmitted, and cinnabar red by reflected light. The color is not permanent. The author questions whether this may not be due to the presence of menthol or of a hydrocarbon associated with the essence.

A case of **decomposition of choral hydrate.**—M. Tauret.—On mixing chloral hydrate, potassic permanganate, and potassic hydrate, gas is disengaged and hydrated manganese sesquioxide separates. On filtering, the liquid will be found to contain potassic chloride, carbonate, and formiate. The gas disengaged was found to be carbon monoxide.

On a **new solvent for phosphorus.**—M. Gerrard.—Colophony is the agent proposed. It will dissolve about 4 per cents of phosphorus.

On **bleaching ivory and bones.**—M. Cloes.—Essence of turpentine is recommended.

Deodorizing carbon bisulphide.—M. Yoon.—Copper turnings placed in contact with the bisulphide will remove the objectionable odor.

La Sucrerie Indigene.

Vol. ix., No. 9.

Note on the **gums of sugar factories.**—P. Jubert.—These gums were recently investigated by Dr. Scheibler, who concludes that they resulted from the use of unripe beets, and from them he obtained a body which he called dextrane. The author differs from him, citing several facts which he has noted, which lead him to the belief that the gums (or as they are called by the men, frog-spawn) are organisms rapidly inducing some form of fermentation. Heating to 90° he states will destroy their vitality.

Method and table for polarmetric analyses.—E. Perrot.—In testing beet-juice the plumbic subacetate is somehow too concentrated, and some of the precipitate first formed is redissolved in the precipitant, thereby causing error. To obviate this the author proposes to take 160 c. c. of the juice and to add to it 20 c. c. of a solution containing 10 grammes of tannin per litre, and then 20 c. c. of plumbic subacetate. The excess of lead is thus precipitated as tannate. A table of the indications of the polariscope (Soleil's), with the percentages of sugar corresponding, when the solution is thus prepared, is given.

Note on the **defecation scums,** and the danger of having them near sugar factories. E. Perrot.—These scums invariably contain the spores of an alga which exerts a destructive effect on a juice when alkaline, causing fermentation. It is therefore recommended that they be disposed of where the spores may not gain access to the sugar solutions in a factory. E. W.

Journal für Gasbeleuchtung.

No. 22.

On **leaden supply pipes.**—Dr. Schilling.—Leaden supply pipes for gas have been used in Munich, some having been in use since 1850. This kind of gas piping has, however, been found to allow about twice as much gas to escape as an iron one, and, therefore, is being replaced by iron. The details of the experiments establishing this point are given. E. W.

Annalen der Chemie u. Pharmacie.

Vol. 172, No. 1.

A condensation product of **glyoxal.**—Hugo Schiff.—Obtained by the action of acetic acid on glyoxal in presence of hydrochloric acid, and analyzes as $6C_2H_2O_2 + H_2O = C_{12}H_{14}O_{13}$.

Improved **air-bath** for heating sealed tubes.—J. Habermann.

On the oxidation of **starches** and para-starches (para-amylums), with bromine, water, and argentic oxide.—J. Habermann.—Bromine acts rapidly on starch, forming dextronic acid. "Para-amylum" also forms an acid, but it differs from dextronic acid. The author has found that gluconic acid is crystallizable, but with difficulty.

On the quantity of **sodium in ashes of plants.**—G. Bunge.—Sodium, although found in minute quantity in some plants, must play an important part in their physiology. By using accurate processes, the author was able to determine it quantitatively in plants where it was considered to be absent.

On **oxysulphobenzide** and some new derivatives thereof.—J. Annaheim.—Sulphanisolide, discovered by Cahours, is oxysulphobenzide in which the two hydroxyl groups are exchanged for methyl. Other compounds with alcohol radicles were formed, and are here described.

On **normal hexylene** and some of its derivatives.—Otto Hecht and Julius Straup.

No. 2.

On the salts of **parabanic acid.**—N. Menschutkin.

On the oxidation of **colophonium and turpentine.**—Dr. Josef Schreder.—Nitric acid oxidizes colophonium and forms isophtalic acid, trimellithic acid, and terebinic acid, and a syrupy mass. From turpentine were formed terephtalic, terebinic, and a syrupy mass. Oxalic acid was not found.

On the transformation of **cinchonidine into an oxy-base.**—Dr. Joh Skalweit.—Cinchonidine is treated with bromine in carbon disulphide, and the bibromcinchonidine is crystallized, taken up in alcohol, boiled with alkali, and the new oxy-base crystallized, $C_{20}H_{24}N_2O_3$. It does not appear to be identical with oxychinin. The manner of preparation would indicate the name "bioxycinchonidine."

On **ferrous anhydrosulphate.**—T. Bolas.—Nine volumes of conc. sulphuric acid added to one volume of a saturated solution of ferrous sulphate, forms a precipitate white and crystalline. The analysis shows this to be FeS_2O_7. On addition of water the ordinary sulphate is formed.

On the cyanogen and carboxyl derivatives of **diphenyl.**—Oscar Doebner. These researches lead to the conclusion that the carboxyl derivatives of diphenyl (acids), are not identical with the acids from phenanthren. The preparation and properties of the compounds obtained are given.

On the normal **phenylpropyl alcohol and allylbenzole.**—L. Ruegheimer.

Experiments on the **synthesis of allylbenzole.**—Rudolph Fittig.—A series of experiments with negative results.

On the constitution of **piperic acid.**—R. Fittig and W. H. Mielck.

On the **desulphurizing of "sulph-urea benzoic acid"** (dicarboxylsulphocarbanilide).—P. Griess.—This compound was obtained by the reaction between sulphocarbonyl chloride and amidobenzoic acid. By heating with alkali and mercuric oxide, the corresponding oxy-acid is obtained.

$$\left.\begin{matrix} C_7H_5 \\ C_7H_5 \end{matrix}\right\}\begin{matrix} NH \\ (CS)'' \\ NH \end{matrix}\Big\}O_2 + HgO = \left.\begin{matrix} C_7H_5 \\ C_7H_5 \end{matrix}\right\}\begin{matrix} NH \\ (CO)'' \\ NH \end{matrix}\Big\}O_2 + HgS.$$

On **carbon tetraiodide.**—M. G. Gustavson.—This was obtained by the action of aluminum iodide and carbon tetrachloride in bisulphide of carbon solution; crystallizes in the regular system; sp. gr. at 20·2° = 4·32. Chlorine decomposes it, forming the chlorine compound.

No. 3.

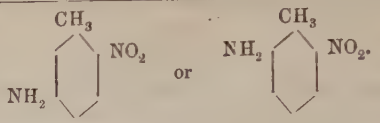
On **metatoluidin.**—F. Lorenz.—A method for its preparation is given, but too long to be abstracted. Colorless oil; becomes darker when exposed to the air. Boils at 197°; sp. gr. at 25° 0·998. Some of its salts are described.

Notice on the quantitative estimation of **paratoluidin when with orthotoluidin.**—F. Lorenz.—Add an excess of oxalic acid over what is required to convert both bases into oxalates, filter out the para-salt, wash with ether, evaporate filtrate, take up in a little water and titrate with soda solution.

On the **metabromortho-sulphotoluic acid.**—Dr. E. Weckworth.—After describing the acid and its compounds, it is noticed that by boiling it with moist argentic oxide, the bromine is very readily removed, OH taking its place. The ortho-acid acts in the same manner with silver oxide. This indicates a convenient way for preparing cresols.

On **orthoamidopara-sulphotoluic acid.**—Dr. M. Haydrick.

On a new **nitrotoluidin.**—Dr. O. Cunerth.—This compound is obtained from liquid dinitrotoluol. It crystallizes in long bright yellow needles, soluble readily in alcohol, with difficulty in water. Fusing point 94°·5. Dissolves in acids when concentrated, forming very unstable compounds. Its formula is either—



On **paramido-orthosulphotoluic acid.**—Dr. F. Jenssen.

On some decompositions of **pyruvic acid.**—Dr. C. Böttinger.—In acid solution pyruvic acid is decomposed, yielding uvinic acid, $C_7H_8O_3$, which acid is described. Some doubts are cast as to the existence of uvitonic acid. Uvitic acid is produced by decomposition with baric hydrate.

On **acenaphthene** and **naphthalic acid.**—Arno Behr and W. A. Van Dorf.—Acenaphthene is a hydrocarbon, $C_{12}H_{10}$, discovered by Berthelot, and is found in coal-tar. Fusing point about 93°, boiling point 277½°. With picric acid it forms orange-red prisms, with fusing point 161°–162°. Naphthalic acid is obtained by oxidizing the above-mentioned compound with potassic chromate. Its formula is $C_{12}H_6O_4$. It is described as insoluble in water, slightly soluble in ether, readily in warm alcohol. Crystals are reddish-yellow, purified by sublimation.

Researches on the **volume constitution of solid bodies.**—Dr. H. Schrœder.

Examination of by-product from **benzole manufacture.**—K. Helbing.—This product was submitted to fractional distillation, and contained amylene, crotonylene, and some hexylene.

Examination of a **new asphalt.**—K. Helbing.—This was found in a stone quarry near Enzenan, within the Lower Alps, in large quantity. It is of a dark-brown color, readily pulverized, and gives a yellowish-gray powder. It melts at above 300°, and burns, leaving much carbon. Taking out ash, which is calculated as pyrites, about 14%, the analyses given are as follows:—

C	86·68	87·46	87·32
H	11·14	11·25	11·07
O	2·18	1·29	1·61

On **cymols.**—F. Fittica.—The cymol from camphor, "ptychotisöl," and thymole are identical. The propyl contained in cymol is normal propyl. From the cymols which contain methyl and normal propyl are derived two phenols.

Constitution of benzol.—A. Ladenburg.—The author has studied at length the constitution of benzol, under the following heads: (1) Similar value of hydrogen atoms in benzol. (2) Number of isomeric bi-substitution products. (3) Determination of position in aromatic compounds. (4) Benzol formulæ.

On derivatives of **phloretin.**—Hugo Schiff.—Embracing the preparation of phloretin, phloretic acid, and phloroglucin, and describing a phloroglucid and triphloretid.

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On some **ethereal oils.**—Ap. Kurbatow.—The gum called "Weihrauch," or frankincense, was separated into an oil, boiling at 160°–170°, and on fractional distillation two portions, boiling respectively at 160° and above 175°, were obtained. The former gives as formula $C_{10}H_{16}$, and is named by the author "oliben." Also a resin containing—

C	16·96
H	10·97
O	12·07

The ethereal oil of the roots of acorus calamus contains a portion boiling at 158°–159°, with formula $C_{10}H_{16}$.

On **sulphopropionic acid.**—Ap. Kurbatow.—This acid is obtained by adding 1½ pints SO_3HCl to 1 pint of propionic acid. It is purified, and forms then a thick syrup very soluble in water and alcohol.

On **ethyl sulphurous ether.**—Ap. Kurbatow.—Best obtained by treating argentic sulphite with ethyl iodide.

On **isomeric sulphocinnamic acids.**—W. Rudnew.—Cinnamic acid yields two sulpho-acids, the para- and meta-compounds, but the author failed to form an ortho-compound.

Formation and decomposition of **metallic sulphides.**—Dr. Karl Henmann.—The action of metallic copper and other metals upon ammonium sulphides, also of cupric oxide, is studied. Metallic copper is first covered with a crust of sulphide, and after the ammonic salt is decolorized hydrogen gas is liberated.

Contributions to the knowledge of the **ammonia derivatives of benzol.**—H. Salkowski.

Investigations on the **volume constitution** of solid bodies.—Dr. H. Schroeder.

On **cinchonin.**—Dr. H. Weidel.—By treating cinchonin with nitric acid (sp. gr. 1·4) four acids are obtained, which have been named as follows: Cinchonic acid $C_{20}H_{14}N_2O_4$, cinchomeronic acid $C_{11}H_8N_2O_6$, chinolic acid $C_9H_6N_2O_4$, and oxycinchomeronic acid $C_{11}H_8N_2O_8$. The reactions by which these acids are formed are given as follows, starting from cinchonin:—

$$C_{20}H_{24}N_2O + O_8 = C_{20}H_{14}N_2O_4 + 5H_2O.$$

$$C_{20}H_{14}N_2O_4 + HNO_2 + 5HNO_3 = C_{11}H_8N_2O_6 + C_9H_6N_2O_4 + 3H_2O + 4NO_2.$$

and $$C_{11}H_8N_2O_6 + O_2 = C_{11}H_8N_2O_8.$$

This is a long and comprehensive article.

Vol. 174, No. 2.

Notice on the conduct of **iodine towards arsenious acid.**—M. Wegner.—The author has failed to prepare iodarsenic acid according to the process of Zinno, and concludes that it does not exist. A solution of arsenic acid mixed with hydriodic acid produces on evaporating arsenious acid and free iodine. Iodine and arsenious acid in dilute solution furnish hydriodic acid and arsenic acid.

Ammonia derivatives of acetone.—W. Heintz.—This investigation shows that ammonia acts upon acetone forming nitrogenous basic compounds, but there are never less than three such bases produced, and none of these have the composition which Staedeler ascribed to his acetonin.

On some **diphenyl formations** within the molecule.—C. Graebe.

Notice of a **palladium salt.**—W.—A solution of palladium chloride turns yellow when treated with sulphurous acid. If now a solution of sodic hydrate be added, a white voluminous precipitate forms, increasing and becoming crystalline on standing. It is soluble in excess of either reagent. It is decomposed by boiling water. Its formula is $PdOSO_2 + 3NaOSO_2 + 2Aq$.

On **diphenyl.**—Gustav Schultz.—A lengthy article on diphenyl and its compounds.

On the constitution of **dioxybenzoic acid.**—L. Barth and C. Senhofer.—Oxybenzoic acid and isophthalic are ortho-compounds, dioxybenzoic acid is 1, 2, 3, and gallic acid 1, 2, 3, 4.

On **benzoltrisulphuric acid.**—C. Senhofer.—By the action of phosphoric anhydride and oil of vitriol on benzol, three hydrogen atoms in the latter are replaced by SHO_3. The operation is conducted in closed tubes at a temperature of 280° to 290°. The potassium salt crystallizes as $C_6H_3(SO_3K)_2 + 3H_2O$. Other salts are described.

Investigations on the **volume constitution** of solid bodies.—Dr. H. Schroeder.

No. 3.

Contributions to the knowledge of the **ammonia derivatives of benzol.**—Dr. H. Salskowski.—Second part.

On the synthesis of **methyl aldehyde.**—B. C. Brodie.—By proceeding in a certain manner the author has succeeded in producing methyl aldehyde by the action of electricity upon a mixture of carbonic anhydride and hydrogen.

$$CO_2 + 2H_2 = COH_2 + H_2O.$$

He thinks there is reason to believe that the marsh gas obtained in former experiments using carbonic oxide and hydrogen was produced by the decomposition of aldehyde first formed—

$$(COH_2)_2 = CO_2 + CH_4.$$

On **paradipimalic acid, diacrylic acid,** and **paradipinic acid.**—J. Wislicenus.—The salts of hydrocrylic acid lose water on heating, and then have the composition of acrylates, but they are not true acrylates. They absorb water, with production of heat, which is not water of crystallization. When certain salts are submitted to this treatment, a portion of the mass is an acrylate and the rest a salt of paradipimalic acid.

On the constitution of **dinitroethylic acid.**—Sylvester Zuckschwerdt.—This acid is obtained by the action of nitric oxide on zinc ethyl. The free acid is $C_2H_5N_2O_5OH$ in which the alcohol radical is combined directly with an atom of nitrogen.

On the products of the **oxidation of ethylsulphuric acid by nitric acid.**—Sylvester Zuckschwerdt.—The product of the reaction of nitric acid on the above-mentioned acid is

$C_2H_5.SO_2$
$C_2H_5.SO_2—N=O$, and its production is explained by
$C_2H_5.SO_2$

$$6C_2H_5SOOH + 3HNO_3 = 3(C_2H_5.SO_2)N=O + 2NO + 3C_2H_5.SO_2OH + 3H_2O.$$

Constitution of **crotonic acid.**—W. Hennilian.—Solid crotonic acid is $CH_3—CH=CH—CO.OH$. Isocrotonic acid is $CH_2=CH—CH_2—CO.OH$.

On the action of **nascent hydrogen on benzoine.**—Dr. H. Goldenberg.—Dibenzyl is readily obtained by reducing benzoine with zinc and hydrochloric acid, and heating to 180° with hydriodic acid. The dibenzyl crystals are readily purified, and melt at 50°.

Some observations on the **Java calisaya** and on **cinchonine.**—O. Hesse.

On **orthoamidoparasulphotoluic acid.**—M. Hayduck.—Second part.

On some **bromamidosulphotoluic acids.**—M. Sharfer.—Some experiments to determine the position of the NO_2 group in the benzol residues of certain amido-acids.

On **fumaric acid** and optically inactive malic acid from glyceric acid.—A. Werigo and Tanatar.

Addition to the treatise on the preparation of **iodine substitution products** with iodine and mercury.—P. Weslesky.—Contrary to the statement in the former article, amylene under the influence of mercury, iodine, and alcohol forms the iodhydrin.

$$\left.\begin{matrix}(C_5H_{10})_2\\C_2H_5I\end{matrix}\right\} O.$$

R. H.

RECENT CHEMICAL PATENTS.

December 15th, 1874.

157,733.—Processes for the Manufacture of Glass.—Bashley Britten, Red Hill, England. Treating slag from smelting furnaces with silicious materials and alkali.

157,749.—Apparatus for determining Specific Gravity of Gases.—W. W. Goodwin, Philadelphia, Pa.

157,778.—Voltaic Batteries.—R. Arthur, Baltimore, Md.

157,856.—Fulminating Compounds.—J. M Milbank, Greenfield, Conn. Potassic chlorate, potassic cyanide, and red phosphorus.

157,864.—Manufacture of Paint.—J. B. Orr, Glasgow, North Britain. Two equal parts baric-sulphate liquor; precipitate one by zincic chloride or nitrate, the other by zincic sulphate. The precipitates are calcined and cooled.

157,873.—Safety-Match Compositions.—G C. J. Schneider, Erie, Pa. Brick-dust, potassic chlorate, yellow sulphuret of antimony, flowers of sulphur, starch, and water.

157,903.—Artificial Stone.—Achille Bérard, Oakland, Cal.—Sand, gravel, waste iron, and Portland cement.

December 22d.

157 917.—Compounds for Preventing and Removing Incrustations from Steam boilers.—J. J. Lavo, Kansas City, Mo. Caustic-soda, chloride of iron, baric chloride, molasses, vinegar, glycerine, and water.

158,094.—Putting up Caustic Alkalies.—A. K. Lee, Galveston, Texas. Treating wood and paper to cause them to resist alkaline action.

158,095.—Manufacturing Anti-Corrosive Compounds, A. K. Lee, Galveston, Texas. Removing pyroligneous acid from turpentine and dissolving in the refined product paraffine and asphaltum.

December 29th.

158,228.—Compounds for Lining Gas-Retorts.—E. G. Wellman, Brockport, N. Y.

158,265.—Processes and Apparatus for the Manufacture of Aqua-Ammonia.—L S. Fales, Cincinnati, O. Utilizing spent liquor from gas-works.

BOOKS RECEIVED.

Report on Sewerage in the City of Providence. By J. Herbert Shedd, Chief Engineer of the Providence Water Works. 8vo. 84 pp. Providence, R. I., 1874.

Address delivered on the Occasion of the Semi-Centennial Anniversary of the Franklin Institute of Philadelphia. By. R. E Rogers, M.D. Pamphlet, 8vo. 37 pp. Philadelphia, Pa., 1874.

Ueber Verbindungen mehrer Alkaloïde mit Jod. Von Harry R Bauer. Pamphlet, 8vo. 23 pp. Halle, Germany, 1874.

Bolley's Handbuch der technisch-chemischen Untersuchungen. Eine Anleitung zur Prüfung und Werthbestimmung der im gesammten Gewerbswesen oder der Hauswirthschaft vorkommenden und zur chemischen Untersuchunggeeigneten Natur- und Kunsterzeugnisse. Vierte Auflage ergänzt und bearbeitet von Dr. Emil Kopp, unter gefälliger Mitwirkung von Rob. Gnehm und Georg Wyss. Erste Abtheilung Pamphlet, 8vo. 400 pp. Leipzig, 1874.

Ueber eine neue Verunreinigung der Kaufichen Ammoniak-flussigkeit. Von Dr. G. C. Wittstein. Pamphlet, 8vo. 3 pp. Extracted from Dingler's Polytechnisches Journal.

Exposition Universelle de Vienna, 1873.—Documents et Rapports des Jurés et Délégués Belges. IVe Groupe. Les substances Alimentaires et de Consommation comme Produits de l'Industrie. Par E. Ganthy, Membre du jury pour le IVe Groupe. Pamphlet, 8vo 89 pp. Bruxelles, Belgium, 1874.

Handbook of the Kansas State Agricultural College, Manhattan, Kansas. Pamphlet, 8vo. 124 pp Manhattan, Kansas, 1874.

On the use of a Glazed Wrought-Iron Combustion Tube for Nitrogen Determinations. By A. P. S. Stuart. Pamphlet, 8vo. 4 pp.

Report of the Medical Commission upon the Sanitary Qualities of the Sudbury, Mystic, Shawshine, and Charles River Waters. Pamphlet, 8vo. 108 pp. Boston, Mass., 1874.

Formation of Paratolnic Acid from Parasulphuric Acid. By Ira Remsen. Pamphlet, 8vo. 7 pp.

BREVITIES.

Dr. Thomas Anderson, late Professor of Chemistry in the University of Glasgow, died November 2d, fifty-six years of age.

Sulpho-carbonate of Baryta.—M. Shenan. If a concentrated solution of baric sulphide is shaken with sulphide of carbon, a heavy, canary-yellow, crystalline precipitate of pure sulpho-carbonate of baryta is obtained. This salt is at present used in great quantities for the destruction of the phylloxera, now devouring the French grape crop.

Guano.—Guano, produced principally by the excrement of pelagian birds, forms, on a number of small islands of the Pacific Ocean, deposits of such an extent that several travellers have thought their origin should be attributed to an epoch in geology prior to the present. Humboldt inclined to this opinion, but the most recent observations, and particularly those of our learned *confrère*, M Boussingault, tend to prove that these deposits are due to aquatic birds and beasts of the present time, which exist here in countless numbers, and whose excrement is preserved by reason of the rarity of rain-falls.

The existence of the bodies of birds found buried in the guano with their soft parts preserved, supports this theory, and it was interesting to know whether these belong to classes which are living at present in this part of the globe. Our *confrère* M. Barral, having received many specimens, and wishing to present them to the Museum of Natural History, has attentively studied their zoological characteristics.

One of the birds, partly mummified, is the Cormorant described by Lesson under the name *Graculus Gaimardis*, which is common along the Peruvian coast; the next is the *Sulu piscator* of Linnæus, a large web-footed bird which differs but slightly from the Gannet of our coasts, and which frequents all parts of the Pacific Ocean; a third is a species of the family of Petrels, belonging to the sub-genus *Pelecanoïdes* of Lacepede (the *P. Garnoti* of Lesson); the fourth and last is the Penguin, which is common to the western coast of South America, and which is known to ornithologists under the name of *Spheniscus Humboldtii*.

There are also among these remains fragments of the bones of mammals belonging to the eared seal, probably the *Otaria Jubata* of Desmarest. Thus all these specimens belong to species which are now living in those regions where guano is found. But they extend very much further south, and if deposits of guano have not been found in the colder islands of the Pacific Ocean, it is probably because the rain-falls have removed the birds' excrement which has accumulated there.—Milne-Edwards, in *La Nature*.

The Great Apparatus of the Conservatory of Arts and Measures for the Fusion of Platinum.—Our illustration represents the magnificent apparatus lately constructed at the Conservatory of Arts and Measures, and which aided, on May 13th last, in the fusion of 250 kilogrammes of platiniridium, intended for the formation of the international standard measure. This vast furnace, arranged on the principle already used by MM. H. Sainte-Claire Deville and Debray, surpasses in its dimensions all those that have been hitherto constructed for a similar purpose.

The experiment performed by MM. H. Sainte-Claire Deville and Tresca has succeeded beyond all expectations; it has demonstrated that the liquefication by heat of great masses of platinum is no longer an obstacle to science.

The ingot of platinum that was taken from the interior of the apparatus, had a volume of about 12 litres, its length is 1·15 metres, its breadth 0·17 metre, and its thickness 0·08 metre, its value is estimated at 250,000 francs. An equal mass of this metal has never before been fused.

The furnace of the Conservatory is 1·4 metres in length; it is formed of the stone of Saint-Waast, the substance of which is a large-grained limestone, containing about 5 per cent of silica. When it is necessary to melt a small quantity of platinum in the laboratory by the aid of the oxy-hydrogen blowpipe, a crucible of unslaked lime is used, as it resists the action of the highest temperature attainable.

This substance, however, does not admit of the construction of a crucible of large size. MM. Deville and Tresca have had recourse to limestone and carbonate of lime.

Under the action of heat the surface of the crucible is decomposed, the carbonic acid is freed and leaves the lime with which it was united. With ordinary limestone this escape of gas causes great inconvenience, as the bubbles of gas pass through the bath of molten metal and form irregularities on its surface; besides the ingot after cooling adheres firmly to lime with which it is in contact. It was necessary to find a stone of special quality; that of Saint-Waast, being porous and easily pulverized, gives the very best results. When platinum is melted in the cavity cut in this stone, the carbonic acid only escapes along the borders of the liquid mass without passing through it; the decomposition of the limestone takes place to the depth of about ·02 metre, so that the metal really rests on a bed of lime of quite a considerable depth.

At two ends of the furnace are two cylindrical openings through which the bars of platiniridium to be fused were successively introduced. When the seven blowpipes, represented on the upper part of the cover through which they pass, were lighted, the platiniridium fused with great rapidity. Small openings gave a view of the interior and the melting metal. It was of a dazzling silver-white, as fluid as mercury, and formed a reflecting surface like that of a mirror. By the lateral openings the large intensely-luminous flames could be seen bursting forth. The temperature was in the neighborhood of 2300° C., which is a little above the melting-point of platinum.

The seven blowpipes were connected by rubber tubes, with reservoirs of illuminating-gas and oxygen. These tubes are attached to cocks, and united by a sphere of copper, as our cut shows.

The consumption of oxygen in the experiment of May 13th was nearly 120 litres per kilogramme of platinum; in the former operations a volume of 150 litres was required. The results recently obtained are in favor of the happy arrangement of the beautiful apparatus of the Conservatory of Arts and Measures.—Gaston Tissandier, in *La Nature*.

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Vol. V. No. 10.

CHEMICAL NOTES FROM THE LABORATORY OF THE LEHIGH UNIVERSITY.

I. On the Blue Color of Refuse Zinc Retorts.

BY F. C. DEGENHARDT.

At the Lehigh Zinc Works at Bethlehem, the clay retorts, used in the Belgian process for the reduction and distillation of metallic zinc, acquire after some little use a blue color, and, in certain parts of the furnaces where the heat is greatest, the color is very dark blue. This coloration has been attributed by an English authority to particles of carbon. The following analyses and experiments were made with a view of solving this question.

Two specimens were chosen, from old retorts that had been in use, one specimen being of a dark blue, the other white, with bluish specks. Complete analyses of these gave the following results:—

	Dark blue.	White.
SiO_2	41·13	50·10
Al_2O_3	33·48	38·28
Fe_2O_3	2·84	3·42
ZnO	21·47	6·10
MnO	0·37	0·41
CaO	0·92	1·13
MgO	0·47	0·73
	100·68	100·17

Five samples were now chosen varying in color from dark blue to white, and the oxide of zinc was determined in them, as follows: No. I. being the darkest blue, the depth of color decreasing to V., which was nearly white.

	I.	II.	III.	IV.	V.
ZnO	21·47	18·09	15·72	10·72	6·10

The color therefore coincides with the amount of ZnO present. The question now would be as to the form in which the zinc exists in this material. As both strong acids and solutions of caustic alkalies are without action upon the color or the material, the presence of metallic zinc or uncombined oxide of zinc is precluded. Intense ignition has no influence upon it, and the analyses show an entire absence of carbon. The combination of oxide of zinc with the silica, as a silicate of zinc, is also disputed by the fact that the colored substance is not gelatinized by acids, as is the case with these silicates; and also by the fact that upon treating some of the blue retorts, in a finely divided condition, in a platinum crucible with hydrofluoric acid, the silica was entirely dissipated, and the residue maintained its blue color. From these experiments we conclude that an aluminate of zinc is produced by the action of metallic zinc upon the clay, entering into the composition of the retorts, at the high temperature of the zinc furnaces; oxide of zinc thus combines with the alumina, the silica is set free, and we have an artificial aluminate of zinc in a matrix of silica, having the properties of the mineral gahnite, zinc-spinel, which is an aluminate of zinc, ZnO,Al_2O_3.

II. On the Artificial Formation of Gahnite.

BY G. HERBERT P. STEARNS.

As a conclusion to the foregoing investigation upon the blue colored retorts, some experiments were undertaken to form this blue substance.

Experiment (1).—Ammonia alum, zincic sulphate, and sesquicarbonate of ammonia, finely pulverized, were mixed in the proper proportions and strongly heated in a porcelain crucible over a blast lamp for two hours. Upon cooling the residue was white. The reaction would be represented thus:—

$$2(Al.NH_4(SO_4)_2.12H_2O) + ZnSO_4.7H_2O + 2((NH_4)_4H_2(CO_3)_3) = ZnO.Al_2O_3 + 5((NH_4)_2SO_4) + 21H_2O + 6CO_2.$$

Experiment (2).—Ammonia alum was ignited in a platinum crucible and the residual alumina was pulverized and fused with an equivalent proportion of dry sodic carbonate, thus forming an aluminate of soda; this was pulverized and fused with an equivalent proportion of zincic sulphate in a porcelain crucible, over a blast lamp. The residue was yellow while hot, but white when cold.

$$Na_2O.Al_2O_3 + ZnSO_4.7H_2O = ZnO.Al_2O_3 + Na_2SO_4 + 7H_2O.$$

Experiments (3) and (4).—Zincic chloride was substituted for the zincic sulphate in the two previous experiments, but with no bluer results.

Experiment (5).—Metallic zinc was placed in one end of a hardglass tube, and ammonia alum in the other end. The zinc end was heated in a blast lamp, and a current of air was passed through the tube, entering at the zinc end; when the formation of oxide of zinc commenced, heat was applied to the ammonia alum end of the tube, until the volatile matter was dissipated. On cooling the residue of the ammonia alum appeared of a light blue color.

III. Analysis of an Acid Mine Water, from the Empire Mine, Luzerne Co., Pa.

BY W. H. BAKER.

This water was extremely acid, and contained in one United States gallon—

	Grains.
$FeSO_4$	1·338
$Fe_2.3(SO_4)$	30·517
$Al_2.3(SO_4)$	55·128
$CaSO_4$	31·431
$MgSO_4$	3·474
H_2SO_4	23·513
HCl	0·030
	145·431

Such waters are produced by the oxidation of the iron pyrites disseminated in the strata of slates in the coal measures, such oxidation being one or both of the following reactions:—

$$FeS_2 + H_2O + O_7 = FeSO_4 + H_2SO_4.$$
$$2FeS_2 + H_2O + O_{15} = Fe_23(SO_4) + H_2SO_4.$$

Water, being impregnated with these acid sulphates and free sulphuric acid, attacks the slates and sulphates of alumina, lime and magnesia are thus formed. Such undoubtedly was the origin of the above acid mine water.

Such a water rapidly corrodes the iron pumps and valves, and the rapid corrosion of steam boilers in the mining districts is due to the acid nature of the feed waters. Not only the free sulphuric acid, but also the persulphate of iron attacks the iron, being reduced to protosulphate of iron.

$$Fe_23(SO_4) + Fe = 3FeSO_4.$$

To reduce the action of such waters upon the pumps, these are lined with brass; and to render an acid water at all suitable for steam purposes, the best process consists in adding to the water, in proper tanks, milk of lime to neutralize the acidity; after settling, the water may be used. The objection to this water is that it retains in solution sulphate of lime, which incrusts the boilers badly.

SINGULAR ANOMALY OF THE SESQUIOXIDE OF IRON AS PREPARED FROM METEORIC IRON.

BY J. LAWRENCE SMITH, LOUISVILLE, KY.

In my studies connected with the physical, chemical, and mineral characteristics of meteorites, several points of more or less importance have been observed, which have as yet formed no part of my published observations on this class of bodies. One of these observations is, that the sesquioxide of iron, obtained in the result of the analysis of meteoric irons, is always decidedly affected by the magnet, although the temperature to which it may be heated prior to final weighing be but a moderate red-heat, only sufficient to furnish a certain constant weight. This phenomenon was at first attributed to small particles of organic matter from the filter, that may have caused the reduction of a minute portion of the sesquioxide to a lower oxidation. Still later I was led to suspect the presence of some new magnetic metal—a metal, however, closely allied to iron (other than cobalt and nickel, as the oxides of neither of these metals are attracted by the magnet, whether obtained from meteoric iron or from any other source).

Experiments were undertaken to discover such metal, if any existed, but without success, and there the matter rested with me for several years; and until I commenced the study of the Ovifak iron, on which I am now engaged, in developing such facts connected with it as convince me that it is of terrestrial and not celestial origin, the results of which investigation I hope, before long, to submit to the Academy.

The observation in connection with the sesquioxide of iron resulting from meteoric irons, was applied to that from the Ovifak iron, and it was also found to be attracted by the magnet. This anomaly showing itself in two irons that I supposed to be of different origins, it was resolved to make a critical investigation of the sesquioxide of iron obtained from both celestial and terrestrial sources; and if what follows appears too much in detail for the examination of so simple an observation, it was, nevertheless, necessary in order to eliminate, as far as possible, sources of error, and to arrive at correct results.

Materials, etc. used in the Experiments.

The irons experimented with were dissolved in a large excess of a mixture of equal parts of chlorhydric and nitric acids. The filters used were old cotton cloth (perfectly free from lint), stretched over a funnel; the quantity of iron used did not exceed one gramme; the filtration was rapid, and the washing very easy and thorough. Other filtrations were made in funnels, the necks of which were plugged with asbestos.

The heating was conducted in thin, glazed porcelain crucibles of about 40 cubic centimetres capacity, and the heat applied by a small Bunsen burner of 5 cubic feet capacity per hour, the top of the flame spreading over the bottom, and one-half of the sides of the crucible, thus heating to redness two or three decigrammes very readily, the amount usually employed.

As for the magnet used, I would state, that as sesquioxide of iron, in a strict sense, ranks among the magnetic compounds, yet this is only true when very powerful magnets are brought to bear upon it; so the magnet used in all the experiments was a feeble one—a small horseshoe-magnet, capable of sustaining about 200 grammes when the two poles were connected, and, when used, one of the angles of one of the poles was brought near the particles of oxide experimented with.

1*st Series of Experiments made with pure Sesquioxide of Iron.*

The first sesquioxide used was prepared from the purest commercial iron, dissolved in equal parts of chlorhydric and nitric acid, diluted, filtered, and precipitated by an excess of ammonia after filtration.

1. Dried at 110° C., crushed to fine particles, but not pulverized. The magnet, being brought within one millimetre of these particles, *would attract them feebly.*

2. The same heated to 250° C., still showed signs of magnetism.

3. Heated to 425° C., the magnetism entirely disappeared, or could only be made apparent upon the very smallest particles.

4. At red-heat the *magnetism had entirely disappeared*, whether the heat was continued for five or ten minutes only, or during several hours.

All the tests with the magnet were made when the heated oxide had cooled; and the same was done in all the experiments referred to in this paper.

The second sesquioxide of iron used was prepared from pure protosulphate oxidized by nitric acid, and precipitated by ammonia. This, when dried, heated, and tested in the same manner as in the former experiments, gave similar results, viz., that hydrated sesquioxide of iron was always slightly magnetic when dried at a low temperature (even at 50°); but at high temperatures as red-heat all magnetic property disappeared.

The third sesquioxide of iron was prepared from chemically pure iron, of which I had a small quantity presented to me by Johnson & Mathey, of London, that had been made with great care by Matthiessen. The results of these experiments differed in no way from those just detailed.

2d Series of Experiments, with Sesquioxide from Meteoric Iron.

I next took meteoric iron with which to prepare the sesquioxide, using irons from a variety of sources. Those experimented with were the Toluca, Cranbourne, Russel Gulch, Sevier Co., Robertson Co. irons, and the iron from the stony meteorite that fell at Parnallee. These irons were dissolved in the same way as the iron in the first series, viz., with a large excess of chlorhydric and nitric acids, in equal parts, and most of the excess of acid driven off over a water-bath. The solution was then diluted, filtered, and poured into a beaker of hot distilled water, to which had been previously added a large excess of ammonia. The precipitates were washed and dried precisely as in the first series, and oxides examined by the magnet. The following were the indications given by all the oxides, with but very slight difference in degree.

Dried at 110° C., sensibly magnetic when the magnet was brought nearly in contact with the fine particles. Heated to 190° C., magnetism exhibited was about the same; at 300° C., slightly increased; at 450°, decidedly magnetic, and at red-heat more strongly magnetic, particles two or three millimetres in diameter being attracted at some little distance. It made no essential difference if the red-heat was continued only for a few minutes or several hours.

It will be remarked in this series of experiments that the effect of heat was just the reverse of what occurred in the first series; for in those experiments what little magnetic property existed in the oxide as first prepared, disappeared entirely when the oxide was brought to a red-heat.

I would here remark, that the sesquioxide, as usually prepared by me in the analysis of meteoric iron, differs somewhat from the above, the iron in solution being first precipitated by boiling with acetate of soda, and the subacetate of iron subsequently converted into oxide; but the oxide thus prepared still exhibits magnetic properties analogous to that formed by using an excess of ammonia.

From the above results, the question naturally arises as to what is the cause of the difference in the first and second series of experiments; for the conditions under which the oxides were formed are as nearly the same as it was possible to make them, and they were made side by side at the same time.

In the first part of this communication, it was stated that I supposed it might be due to a new metal closely related to iron, but whose oxides were all attracted by the magnet; this idea was discarded after varied and careful experiments that failed to give any evidence of the correctness of such an assumption.

The only thing left for me to do was to look into the oxides of iron from meteoric iron, and see what impurities they contained, and ascertain if these impurities played any part in this magnetic anomaly. It is well known that when a solution of meteoric iron is precipitated by an excess of ammonia, the oxides of nickel and cobalt at first precipitated along with the sesquioxide will be redissolved but only in part, leaving often from one to three per cent. of these oxides mixed with the oxide of iron. It is further known that while nickel and cobalt can be very nearly separated from iron by means of the acetate of soda, still a sensible portion will be left in the precipitated oxide of iron; so much so, that when I aim at exceeding accuracy in this separation, the subacetate at first precipitated (after partial washing) is redissolved and reprecipitated by the acetate of soda, and this operation repeated a second and a third time. While there is nothing in the presence of the oxides of nickel and cobalt that would lead to any explanation of the phenomenon under discussion (for neither of these oxides is affected by the magnet), still I was determined to see what would be the condition of the oxide of iron prepared from meteoric iron after four resolutions and reprecipitations by acetate of soda, finally converting the subacetate of iron into the sesquioxide by dissolving it in aqua regia, and precipitating by ammonia.

The sesquioxide thus prepared no longer possessed the properties of that indicated in the second series of experiments, but showed the same properties as the ordinary oxide of the first series, viz., not attracted by magnet after heating to redness.

It being evident that the minute quantity of the oxides of nickel and cobalt remaining in the sesquioxide as prepared from meteoric iron had something to do with the phenomenon under consideration, I was led to institute a third series of experiments, using the sesquioxide from ordinary iron.

3d Series of Experiments with Sesquioxide of Iron prepared from pure Iron, mixed with Oxides of Nickel, Cobalt, and other Metals.

A quantity of a solution of the sesquioxide was prepared by dissolving pure iron in a mixture of equal parts of chlorhydric and nitric acids, and a portion of the solution equal to about a gramme of the metal used in each of the subsequent experiments, adding to

the solution of iron a solution of the other metals in the same acids prior to precipitation by ammonia.

Some of the iron solution, without any admixture, was precipitated, and the sesquioxide examined as in series 1st, and being satisfied that the pure oxide gave no indication of magnetic attraction, the experiments were proceeded with.

Exp. 1. A solution of the mixed oxides of nickel and cobalt, as obtained from meteoric iron, was added to some of the above solution of iron (the nickel and cobalt oxides representing about 10 per cent. of the iron) precipitated by large excess of ammonia, dried and tested with magnet before and after heating to redness, and the magnetic results were just the same as if we had been experimenting with meteoric iron, detailed in series 2d. This experiment was frequently repeated, and always with the same result.

Exp. 2. Same experiment as last, only using oxides of nickel and cobalt from ordinary sources; the results were the same, only not quite so marked.

Exp. 3. Pure nickel oxide was used, with similar results.

Exp. 4. Pure oxide of cobalt was used, with similar results.

While the above experiments throw some light upon the subject, they in no way explain the phenomenon, for none of the oxides separately exhibit the magnetic property. I therefore continued the experiments, using other metals besides nickel and cobalt.

Exp. 5. Ten per cent. of copper, dissolved in nitric acid, was added to a portion of the solution representing a gramme of iron, and precipitated with an excess of ammonia. The oxide dried and heated as in the previous experiments. When tested with the magnet it gave indications similar to the oxide from meteoric iron, but less in degree. In subsequent analyses of this oxide thus precipitated, it was found to contain nearly 3 per cent. of oxide of copper.

Exps. 6, 7, 8, 9, and 10. In these experiments oxides of manganese, gold, platinum, zinc, and cadmium were employed as admixtures with the iron; but in all cases the precipitated oxides differed in no way from the pure oxide of iron; when tested by the magnet evincing no attraction after being heated to redness.

The above experiments embrace all that I have made up to the present time, and the results that are new may be summed up as follows:—

First. That artificial hydrated sesquioxide of iron, dried at low temperatures, is attracted feebly by the magnet, but loses this property at and below red heat.

Second. That sesquioxide, precipitated in the ordinary methods from solutions of meteoric iron, and dried at a low temperature, acts similarly to the ordinary oxide, but differs from it in that it becomes decidedly magnetic on being heated from 400° C. to a red heat.

Third. That the sesquioxide from ordinary iron, mixed with nickel or cobalt, or both, from whatever source, exhibits magnetic properties identical with that from meteoric iron.

Fourth. That the sesquioxide of iron from meteoric iron, freed entirely from traces of nickel and cobalt, corresponds to the ordinary sesquioxide in its behavior to the magnet.

Fifth. That the sesquioxide made from iron mixed with copper resembles that from meteoric iron.

Sixth. That the sesquioxide from iron mixed with manganese, gold, platinum, zinc, or calcium differs in no way from the pure sesquioxide in its magnetic reaction.

A natural inquiry is, what is the cause of this change in the sesquioxide of iron when mixed with oxides of nickel, cobalt, or copper? Analyses of mixed oxides have thrown very little light on the subject; for by carefully reducing the oxides by hydrogen, analyzing the mixed metals (that usually gave from two to three per cent. of the copper, nickel, or cobalt), and calculating on the basis of all the iron being sesquioxide, my analytical results and calculations never differed more than from one to one and a half milligrammes in one gramme of the oxide that was used, and this difference is within the limits of error, yet it corresponds to amount of from two to three per cent. of Fe_3O_4 mixed with the sesquioxide. And in want of any better explanation, I must suppose that the presence of the small amount of oxides of these foreign metals does cause a reduction of a minute quantity of the Fe_2O_3 to Fe_3O_4, although a bright red heat, however long continued, will not increase the magnetic property of the oxide, it having received its maximum as soon as it arrives at a red heat.*

STUDY OF THE QUANTITATIVE EFFECT OF TEMPERATURE IN THE REACTION OF OXALIC ACID UPON POTASSIC PERMANGANATE.

BY MISS MARY F. REED,

Assistant in Chemistry in the Laboratory of the Worcester Free Institute of Industrial Science.

In 1866 Messrs. Harcourt and Esson published in the Philosophical Transactions of the Royal Society, the results of certain investigations which were made to ascertain the laws of connection between the conditions of chemical change and its amount.

In these investigations the temperature was kept constant. At the suggestion of Prof. Kimball, I have made several series of experiments to determine the amount of chemical change, in a given time, at different temperatures.

The reaction studied by Messrs. Harcourt and Esson, namely, of oxalic acid upon potassic permanganate, was used in these investigations.

The reagents were mixed and allowed to act upon each other for a certain time under conditions which,

* It has been suggested to me, by Prof. C. F. Chandler, that the nickel, cobalt, and copper oxides present may form with the sesquioxide of iron a magnetic oxide, thus: NiO,Fe_2O_3, analogous to FeO,Fe_2O_3. The suggestion is a reasonable one, and worthy of consideration.

with the exception of temperature, were carefully kept constant.

The action was abruptly terminated by an addition of an excess of potassic iodide; and the quantity of iodine released, measured by a standard solution of sodic hyposulphite, gave the amount of unreduced potassic permanganate. The solutions of oxalic acid, potassic permanganate, and sodic hyposulphite were deci-normal.

The potassic iodide was twice this strength.

For this experiment 25 c.c. of potassic permanganate and 50 c.c. of oxalic acid, to which 2½ c.c. of sulphuric acid of 1·8 sp. gr. had been added, were taken.

The oxalic acid, in the first series, was allowed to act upon the potassic permanganate 4 minutes. In the four succeeding series 2, 1, ½, ¼ minutes. The results for each series may be represented graphically by a curve whose ordinates show the percentage of chemical change in the time, and whose abscissas show the temperature. The 4 minute curve exhibits a very slight but uniform increase in the amount of chemical change for each degree until a temperature of 27° C. is reached. From this point the increment of chemical change for each degree is quite large and increases rapidly to 35·5°. From 35·5° to 38° this increment is very large but is nearly constant. From 38° to 42° it is much smaller, and rapidly decreases in value.

At 42° the reduction is complete. In the 6th, 7th, and 8th series solutions of the following strength were used.

Per Litre.

	Grammes.
Oxalic acid	32·4
Sulphuric acid	17·6
Manganous sulphate	5·
Potassic permanganate . . .	·375

25 c.c. of each were taken. The times assumed were 4, 3, 2 minutes.

The curves are similar in form to those obtained in the preceding series, but more gradual.

Table showing the percentage of Chemical Change at Different Temperatures.

Temperature.	1 ¼ min.	2 ½ min	3 1 min.	4 2 min.	5 4 min.	6 2 min.	7 3 min.	8 4 min.
C.								
5°. .						·03	·04	·04
10°. .						·035	·046	·05
15°. .			·03	·06	·09	·05	·08	·095
20°. .			·035	·065	·115	·087	·155	·19
25°. .			·038	·08	·135	·17	·33	·40
30°. .			·049	·10	·185	·36	·58	·655
35°. .		·025	·07	·165	·42	·625	·785	·845
40°. .	·025	·075	·165	·35	·975	·845	·93	·975
45°. .	·045	·145	·335	·905		·975		
50°. .	·10	·2 5	·70					
55°. .	·19	·53	·985					
60°. .	·345	·895						
65°. .	·66							
70°. .	·97	.						

This table shows the result of over two hundred experiments.

ON THE FORMATION OF SOLID OXIDIZED HYDROCARBONS, RESEMBLING NATURAL ASPHALTS, BY THE ACTION OF AIR ON REFINED PETROLEUM.

BY WALTER P. JENNEY, E.M.

In conducting a series of experiments on the oxidation of petroleum by heating it to a temperature slightly below its boiling point, and passing a current of oxygen slowly through it, the action being sometimes assisted by the addition of litharge or potassic permanganate, I noticed that a solid deposit formed on the bottom of the flask, which I at first supposed to be coke, produced by the "cracking" of the heavy oils; but finding that it was soluble in chloroform, and that the oils which had been subjected to these experiments deposited on standing a brown precipitate, I determined to investigate more thoroughly these peculiar substances. A small brass still, having a capacity of about two litres, was filled with crude Pennsylvania petroleum (gravity 47° Baumé), and a rapid current of air aspirated through it; the temperature was kept at from 140° to 145° C., and the experiment continued for twenty-four hours, but owing to the slight vacuum produced by the aspirator, and to the effect of the air in removing the vapors of the oil as soon as formed, nearly the whole of the charge was distilled off, and the residue, which was too small in quantity to admit of the experiment being continued, solidified, on cooling from the crystallization of paraffine, to a thick brown mass of the consistency of soft butter. The formation of oxidized solid hydrocarbons was not observed, as the experiment was not continued long enough to produce them in noticeable quantities. Acting upon the information obtained from the preceding experiment, the still was filled with a sample of petroleum distillate of a pale-yellow color, and a gravity of 41° B., which was taken at one instant of time from the oil flowing from the condensing worm of a large still that had been running for nearly twenty hours, and was distilling at a temperature of not less than 350° C. The contents of the still were kept for two days at a temperature of about 100° C., and a rapid current of air continually passed through the oil. On examination the oil was found to be but slightly affected by the air, the color was bright red, only a trace of sediment had formed, and not more than ten per cent. of the oil had been distilled off. The temperature was then raised to 140° C., and to increase the action of the air small quantities of litharge were added to the oil at intervals, and the experiment continued without ceasing for three days longer, when, on opening the still, about forty per cent. of the original charge was found to have been distilled off. The residue consisted of a garnet-red oil of a gravity of 32° B., holding in suspension a large quantity of a chocolate-brown sediment, which was separated by

allowing it to subside, decanting the clear oil, and washing the sediment repeatedly by decantation with petroleum naphtha of 85° B. until the naphtha was no longer colored by agitation with it. On drying, the sediment was an impalpable yellow-brown powder, intermixed with litharge, and containing a small quantity of another substance nearly black in color, which was insoluble in ether, but soluble in choloform; the amount was, however, too small to admit of its composition being determined. It resembled in appearance one of the asphalts produced in the next experiment. The oil decanted from the sediment deposited on cooling a trace of a brown resinous substance, which was insoluble in naphtha. On treating the oil by agitation with concentrated sulphuric acid, a large quantity of a black tarry "sludge" was removed, and the oil, after washing with water and sodic hydrate, was of a pale straw-color, and on cooling to 0° C. solidified from the crystallization of the paraffine which it contained. The brown powder was perfectly insoluble in light pretroleum naphtha, insoluble in boiling alcohol, and not attacked by a boiling solution of sodic hydrate. It was readily soluble in chloroform, bisulphide of carbon, and ether, forming dark-brown solutions, which, on being mixed with an equal quantity of petroleum naphtha, gave a curdy yellow-brown precipitate. The solutions, on being spontaneously evaporated in the air, leave a soft yellow-brown powder, but, evaporated at 100° C., the residue is a brown-black solid with a resinous fracture. On heating the purified powder gradually, it softens at 100° C., and at 140° C. fuses; above that temperature it is decomposed, swelling to about ten times its volume, and burning with a yellow flame and a slight bituminous odor, leaving a light cellular coke. A sample of this brown powder was purified by dissolving it in ether, filtering the solution, and evaporating it in an air-bath at 100° C. The ash was determined by igniting 0·617 grm. of the purified substance in a crucible, moistening the ash with nitric acid, and igniting to oxidize the reduced lead; it left a residue of 0·0395 grm., or six and one-half per cent.

On analysis by combustion in a current of pure oxygen gas in a tube filled partly with oxide of copper and chromate of lead, it gave, deducting the 6·5 per cent. of ash and estimating the oxygen by difference—

				Calculated.	
Carbon	73·00	73·57	73·50	C_{40}	73·40
Hydrogen	7·15	7·18	7·10	H_{46}	7·03
Oxygen	19·85	19·25	19·40	O_8	19·57
	100·00	100·00	100·00		100·00

The brown powder after its formation was kept suspended in the hot oil by the agitation produced by the rapid current of air, and probably absorbed as large a quantity of oxygen as it was capable of uniting with at that temperature; and as the action was long-continued, some of its hydrogen may have been also removed; so, without considering it identical with the mineral hydrocarbon schlanite, I may call attention to its resemblance to that natural asphalt by transcribing from Dana, *System of Mineralogy*, p. 745.

"Schlanite—A dark or light-brown powder, obtained by solution in ether from anthracoxenite."

"Analysis-Laurenz."		Calculated.	
Carbon	81·47	C_{40}	81·63
Hydrogen	8·71	H_{52}	8·85
Oxygen	9·82	$O_{3\frac{1}{4}}$	9·52
	100·00		100·00

"This resin oxidizes slowly when wet and exposed to the air."

The preceding experiments indicated that there were other solid products of the action of air on the oil beside the brown powder, and that, to continue an experiment for more than fifty or sixty hours, an oil having a very high boiling point must be employed, or the action would soon cease from all the oil being carried off in the form of vapor by the current of air. The still was charged with about two litres of "winter-pressed" paraffine lubricating oil having a gravity 28° B. This oil had been distilled from petroleum tar at a red heat, chilled to a temperature several degrees below zero, and pressed, which had removed the paraffine; it had then been heated, and all the lighter oils contained in it steamed out, and it was afterwards treated with sulphuric acid and sodic hydrate, so that it was free from tarry substance and all other impurities. The temperature was kept from 140° to 155° C., and a current of air aspirated through the oil by a Bunsen filter pump, unceasingly day and night for four days, small quantities of litharge being added to the contents of the still from time to time. The air entered by a tube open at the top, inserted through the cover of the still and reaching nearly to the bottom, and bubbling through the hot oil, the vapors were cooled by a Liebig's condenser, and, passing through a Woulf bottle immersed in cold water, finally escaped with the water in the filter pump. A small quantity of oil, which seemed to be mostly mechanically carried over by the air, condensed in the receiver and was put back into the still; but it was evident that a great waste of the charge was continually taking place from light naphthas and uncondensable gases formed by the "cracking" of the paraffine oil by the action of the air, and which, in the form of a white cloud-like vapor, passed through both condensers, and formed a film of oil on the surface of the water flowing from the exit pipe of the filter pump. On opening the still at the end of four days' continuous action, about one-third of its contents were found to have been vaporized by the air. The oil was garnet-red in color, and contained a large quantity of a brown powder in suspension, while on the bottom of the still, over the point exposed to the flame of the lamp, was a solid deposit nearly an inch in thickness, of a substance which, while saturated with oil, could not be distinguished in appearance from coke. The oil, together with the brown sediment, was carefully decanted from the coke-like deposit, allowed to settle, the clear oil decanted from the sediment, which

was washed repeatedly by decantation with naphtha until the washings were colorless. On drying it was a soft-brown powder, several shades darker in color than that produced by the preceding experiment; it was marked for analysis "sample A." The solid deposit was removed from the still and similarly washed with naphtha, and marked "sample B." On testing B, I found that it was completely soluble in chloroform, and contained not even a trace of coke. It was dark-brown in color, with a fracture and appearance closely resembling that of Grahamite. The clear oil decanted from these substances was put back into the still, and the experiment continued as before without ceasing for six days more, at the same temperature; at the expiration of that time the still contained only about fifteen per cent. of the original charge of oil; a little brown sediment had formed. On cooling, a brown substance separated from the oil and was removed; it was soft, and could be moulded and worked in the fingers like putty; kneading under naphtha removed the oil mixed with it, and made it harder and more brittle. Adhering to the bottom of the still was a deposit even more solid than that first formed in this experiment, but exactly resembling it in other respects. It was purified by washing with naphtha to remove adherent oil, and marked "sample C." On examination of the substance that separated on cooling from the oil, it was found to be insoluble in naphtha, and, being also soluble in ether, could not be separated from the brown sediment with which it was mixed; but, finding that the clear oil still contained a considerable quantity of it, it was separated in a perfectly pure form by mixing the oil with twice its volume of light naphtha, the resin precipitating as a curdy, yellow-brown precipitate, which united to a pasty mass, easily purified by first triturating it in a mortar with naphtha, and removing the naphtha by heating it to 100° C., when it fused and solidified on cooling to a brittle, resinous mass of a brown color. This sample was reserved for analysis, and marked "D." The dark-brown powder, marked "A," was dissolved in ether, and the solution filtered and evaporated to dryness in an air-bath at 100°; it left the pure asphalt as a brown resinous substance, resembling in all its reactions with solvents the brown powder from heavy illuminating oil in the preceding experiment. On analysis by combustion in oxygen it gave, deducting 0·22 per cent. ash—

		Calculated.	
Carbon	79·98	C_{40}	80·00
Hydrogen	6·64	H_{40}	6·66
Oxygen	13·38	O_5	13·34
	100·00		100·00

The solid asphalt marked "B" was reduced to powder, and boiled with acetic acid to remove the litharge with which it was mixed; then washed, first with hot acetic acid, until the washings were free from lead, and then with boiling water to remove the acid; and, finally, with alcohol and ether. It was then dissolved in bisulphide of carbon, and precipitated by naphtha as a fine dark-brown precipitate, washed with naphtha, dissolved in chloroform, the solution filtered and again precipitated by naphtha, washed and dried at 100° C. On burning 0·496 grm. of the purified substance, it left a residue of 0·0428 grm. of lead, equal to 0·0461 grm. of litharge, or 9·3 per cent. On combustion in oxygen, deducting the ash, it gave—

		Calculated.	
Carbon	80·16	C_{40}	80·27
Hydrogen	6·48	H_{38}	6·35
Oxygen	13·32	O_5	13·38
	100·00		100·00

Sample "C" was purified by powdering it and washing with ether, dissolving in chloroform, filtering the solution, precipitating with naphtha, washing with naphtha, and drying the precipitate at 100° C. On igniting 0·505 grm. it left a residue of 0·0383 grm. of lead, equal to 8·3 per cent. of litharge. On combustion in oxygen, deducting the ash, it gave—

		Calculated.	
Carbon	76·06	C_{40}	76·19
Hydrogen	6·09	H_{38}	6·03
Oxygen	17·85	O_7	17·77
	100·00		100·00

These asphalts marked "B" and "C" could not be distinguished from each other by their reactions with solvents, they were insoluble in boiling alcohol and in ether, but readily soluble in chloroform and bisulphide of carbon, forming brown solutions precipitated by naphtha as a fine dark-brown powder. On heating gradually they softened slightly, but did not melt without decomposition, and, igniting, swelled and burned with a yellow, smoky flame, leaving a light cellular coke, about twenty times the volume of the original substance. The streak was brown, the fracture resinous, and in appearance the substance resembled closely some of the highly bituminous coals, and the mineral asphalt "Grahamite," from Ritchie County, Va.; but in its action with solvents, and in its chemical composition, bears a singular resemblance to the hydrocarbon "Anthracoxenite" (*vide* Dana, page 746).

"Anthracoxenite, obtained as a black powder from a resin, by separating the remainder by ether, the anthracoxenite being insoluble in ether." "Composition $C_{40}H_{38}O_{7½}$."

	Anthracoxenite.	Sample "C."	
Carbon	75·274	C_{40}	76·06
Hydrogen	6·187	H_{38}	6·09
Oxygen	18·539	O_7	17·85
	100·000		100·00

"From a resin-like material constituting layers 2½ inches thick between layers of coal in the coal beds of Brandeisl, near Schlan, in Bohemia; color brown-black, streak dull yellow-brown, fracture small concoidal, fuses, burns with yellow, smoky flame, and an odor not disagreeable; the part soluble in ether is Schlanite."

The large percentage of litharge retained by these substances even after purification is quite remarkable; it does not seem to affect the chemical composition, and the combining number of lead is so great that even 9 per cent. is but a fraction of an atom in the formula, and I can but regard its presence as not in any way affecting the asphalt.

The resin marked "D" is insoluble in naphtha and boiling alcohol, and in a solution of sodic hydrate, but is readily soluble in oil of turpentine, bisulphide of carbon, and ether, forming garnet-red solutions, precipitated by naphtha as a curdy yellow-brown precipitate, which, on drying, is an impalpable powder, resembling yellow ochre; it is readily soluble in chloroform, but its solution, on adding an equal volume of naphtha, does not precipitate, but changes to a clear hyacinth-red color. Heated, it fuses at 55° C., and burns with a large, smoky, yellow flame and a bituminous odor. On analysis it gave, deducting a trace of ash—

				Calculated.	
Carbon . .	78·67	79·05	78·75	C_{40}	79·20
Hydrogen .	7·61	7·76	7·53	H_{46}	7·59
Oxygen . .	13·72	13·19	13·72	O_5	13·21
	100·00	100·00	100·00		100·00

These four substances, formed from one sample of oil, bear a peculiar relation to each other. The resin "D," which is in solution in the hot oil, has the composition expressed by the formula $C_{40}H_{46}O_5$. Becoming oxidized, it precipitates as the brown powder $C_{40}H_{40}O_5$, and, settling on the bottom of the still, becomes heated to a higher temperature, changing into the solid asphalt $C_{40}H_{38}O_5$, or, by a longer action of air, to $C_{40}H_{38}O_7$.

During the progress of the experiment, not more than a trace of water condensed in the cold receiver, showing that hydrogen was not removed from the oil in the form of water by the action of the air, as had been the case in some previous experiments conducted with oxygen at a temperature of 270° C., but that the hydrogen was removed in the form of light naphthas, and uncondensable gases, containing a greater percentage of hydrogen than the original oil, leaving in the still hydrocarbons rich in carbon and oxygen, but with a small amount of hydrogen. Reviewing these experiments, I can but think that they throw light upon the formation of the natural asphalts found filling crevices in the earth, especially with reference to Albertite and Grahamite, concerning the occurrence and mode of formation of which there has been so much speculation and discussion; and it would seem more probable that those asphalts were formed by the precipitation of solid oxygenated hydrocarbons by the long-continued action of air upon the moderately heated petroleum filling the fissures where they are now found, rather than that they were formed from petroleum by a gradual evaporation of its more volatile constituents.

School of Mines, Columbia College,
March 26, 1875.

PREPARATION OF UREA.

BY J. E. LOUGHLIN, M.D.

Many methods have been devised for the preparation of urea. This substance, first discovered by Rouelle in 1777, was clearly described and named by Fourcroy in 1799. The urine previously filtered is treated with commercial nitric acid (in the proportion 1 ounce nitric acid to 20 ounces urine), and allowed to evaporate spontaneously, the nitrate of urea separates from the urine in the form of blackish-red scales, which are removed and dried by pressing between folds of common filtering paper; these scales are now dissolved in twenty times their weight of distilled water, and heated to 200° F.; when the nitrate of urea is all dissolved, animal charcoal (four times as much as the weight of nitrate of urea used) is added, the whole brought up to a boil, and kept boiling for three minutes, filtered, the filtrate evaporated to one-eighth its bulk, and allowed to crystallize (if the crystals are not sufficiently white the operation must be repeated); the white crystals of nitrate of urea, dissolved in twenty times their weight of water, are mixed with pure carbonate of barium (parts carbonate of barium to parts nitrate of urea); the mixture disengages carbonic acid gas, nitrate of barium and free urea being formed. The whole mass is evaporated to dryness over a water-bath, the residue treated with twenty times its weight of water, and again evaporated to dryness; this residue heated to boiling with 95 per cent. alcohol, filtered, the filtrate evaporated to one-fourth its volume and allowed to crystallize; the crystals dried over sulphuric acid are perfectly pure, and should be kept in a well-stoppered bottle, as they readily deliquesce. The advantages of the above are, 1st. Spontaneous evaporation, whereby the urine is not at all decomposed. 2d. Direct addition of nitric acid, whereby alkaline fermentation and destruction of urea are prevented. 3d. Purification of the nitrate of urea, whereby a pure urea is obtained.

Summer School, Jefferson Medical College,
Philadelphia, March 2, 1875.

THE OCCLUSION OF HYDROGEN BY PALLADIUM.

BY L. H. LAUDY.

The well-known results of Graham's experiments on palladium, and the large volume of gas absorbed when thin strips of this metal are made the terminals of a rather strong current of electricity, are familiar to all. To demonstrate this fact to an audience or class has only lately been attempted, and I have devised a simple piece of apparatus, which I have used many times and have found to be correct and reliable if the following directions are carefully carried out: Pure palladium foils, measuring about one-eighth of an inch in width and three inches long, are attached to stout pieces of copper wire with hard solder, these are passed through pieces of cork cut square, according to size of tank used.

The strips are first heated in a Bunsen burner and allowed to cool. They are then coated with a thin shellac varnish (ordinary negative varnish thinned with alcohol answers the purpose) on one side only, by means of a small camel's-hair brush. Care should be taken to prevent the varnish from flowing on the opposite side. The strips are then placed in the lantern tank, about one and a half inches apart, with the varnished sides toward the sides of the tank and parallel to the light. The tank is filled with dilute sulphuric acid, and the wires from a battery of about four one-quart Bunsen cells are connected with the strips.

Decomposition immediately takes places, hydrogen is occluded, producing a powerful contraction in the palladium. By reversing the current the hydrogen is discharged, and the phenomenon is repeated in the other strip. By these means the strips undergo wonderful contortions. This simple experiment demonstrates the peculiar properties of this metal.

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NOTE ON THE OCCURRENCE OF VANADIUM IN URANINITE.

BY H. CARRINGTON BOLTON, PH.D.

Read before the Lyceum of Natural History in the City of New York, March 8, 1875.

While engaged in purifying a quantity of raw material for the preparation of very pure uranic nitrate, some peculiar reactions were observed, at certain stages of the process, characteristic of vanadic acid, which proved to be present in sufficient quantity for profitable extraction. The occurrence of vanadium in uraninite is no novelty; it was noticed by Wöhler* in the Bohemian mineral as early as 1842; and Patera,† the chemist of the government works at Joachimsthal, has described a method of obtaining vanadium as a secondary product in the preparation of commercial uranates on a large scale. The object of the present note is to show at what stages in the purification of uranic oxide, vanadic acid appears, and to guide those desirous of preparing pure uranic salts.

The raw material forming the starting point was ammonium uranate, purchased of Trommsdorff, and in all probability of Bohemian origin; it was a bright yellow, light, impalpable powder, having every appearance of great purity, but a preliminary examination showed that it contained a considerable amount of arsenic.

The arsenic being combined with the uranic oxide as an arsenate, roasting failed to expel it, and resort was had to the wet process. The material was accordingly dissolved in hydrochloric acid; owing to the partial insolubility of uranic arsenate in the cold, this required a large volume of hot dilute acid. The arsenic was then thrown down by hydrosulphuric acid while the solution was kept warm by a current of steam directed into it. The bulky precipitate thus obtained was of a brownish hue, and proved to be a mixture of arsenious sulphide with uranic sulpharsenide. On treating this precipitate with ammonium carbonate, the former dissolved out, leaving the uranic sulpharsenide as a yellowish-brown, fusible powder. This sulpho-compound was mentioned by Berzelius, but I have seen no notice of its formation in the manner here described.

The method followed in purifying the uranic oxide has been already published in full,* and is here repeated only so far as is necessary to the object of this note. The filtrate from the arsenious sulphide was boiled, oxidized with nitric acid, and mixed with an excess of ammonium hydrate. The yellow ammonium uranate thus precipitated was washed, dissolved in ammonium carbonate, and the solution filtered. This filtrate was then boiled briskly to throw down uranic oxide. The portions of the precipitate which came down towards the last gave a strong red coloration with concentrated hydrochloric acid, which color instantly passed away, This reaction is due to the formation of an acid vanadate of an orange-red color, and the uranic oxide was evidently mixed with uranic vanadate.

The last formed precipitate was then ignited strongly, and the green uranoso-uranic oxide treated with dilute hydrochloric acid, and well washed. Uranates of the alkalies and alkaline earths may thus be extracted. The hydrochloric acid solution obtained was, however, almost free of uranium, as shown by the very weak absorption bands visible in the spectroscope, and proved to be a solution of vanadium oxide.

The next step in the purification of uranic oxide was to dissolve the green oxide in nitric acid, and to submit the uranic nitrate to careful fractional crystallization. Here, again, the vanadium made its appearance, coloring the mother liquid orange-red. Uranic vanadate also precipitated from the nitric acid solution as a light-yellow powder, which was separated by filtration.

Thus the vanadic acid follows closely the uranic oxide, but is recognizable at the three stages mentioned. Most of the tests for vanadium in solution fail in the presence of uranic salts, the latter masking the reactions almost completely. Thus no blue-colored solution can be obtained by reduction, the green of the uranous salt overcoming the blue color. Nutgalls in very neutral solutions give, however, the characteristic black precipitate.

The vanadic acid was finally separated from the uranic oxide in the usual way, by fusion with sodium carbonate and nitrate. On treating with water, uranate of sodium remains, and sodium vanadate goes into solution. A lump of sal ammoniac placed in this alkaline vanadate, throws down ammonium vanadate, and this yields vanadic acid on heating to fusion.

A specimen of uraninite from Colorado, obtained through the kindness of President Henry Morton, was

* Ann. Chem. Pharm., xli. 345.
† Dingl. pol. J., cxli. 372.

* American Chemist, vol. i. p. 50.

examined for vanadium, but with negative results. The mineral proved to contain, however, SiO_2, S, Pb, Cu, Bi, Mn, Zn, Al, Fe, U, Ca, Mg, H_2O. This may be compared with a specimen from Joachimsthal, analyzed by myself in 1866; it contained SiO_2, As, Se, Pb, Cu, Bi, Ag, Fe, Mn, U, Vd, Mg, Ca.

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DETERMINATION OF DISSOLVED OXYGEN IN WATER.

REJOINDER TO H. ENDEMANN. BY HENRY WURTZ.

Editors of the American Chemist:—

Gentlemen: I regret to be forced again to trespass on the patience of yourself and readers by noticing a new attack of Dr. H. Endemann in your January issue, p. 237 (which only came under my attention within a few days).

He begins with what he, no doubt, deems ingenious ridicule, by asserting that I have expressed myself "grieved" that my oxymetric method has received less attention than that of Schutzenberger and Gerardin. He may have written his note previous to the issue of the *Proceedings* of the Lyceum of Natural History for the first *Semestre* of 1874, containing my own Abstract of my Preliminary Notice (which has disagreed with him so painfully). Your readers will there find (pp. 103, 104) the only authorized record of my remark, distorted by his apparently fertile imagination into an expression of grief; to wit: "My own method . . . . . I believe preferable" (*i.e.* to that of S. and G.).

The above is of little moment to your readers, or, in fact, to any one else. I notice it merely as an examplar, and as suggestive of the real *animus* of my assailant. His next paragraph, however, contains the main point of this his second note, and is more important, while quite as significant of the like spirit. No doubt this next point was observed at once by those of your readers who have had patience to read both of his notes. The first one (in your Journal of July, 1874) claimed—citing alleged experiments of his own in support, and assuming, moreover, on my part, a slovenly way of experimenting, which, if true, would prove me an idiot—that free oxygen *could not* be wholly expelled from aerated waters by CO_2. He now says that this expulsion is a "well-known fact," and denies only (an assertion never made by me) that this expulsion is "instantaneous."

Your readers will at once concur with me that a "well-known fact" should be found, and found *repeatedly*, entered upon the record. So far, he has not pointed out even one such entry, even to the limited extent which he is now forced, for the first time, to concede: that in the course of a comparatively *long time* such expulsion is complete. It is scarcely necessary for me, however, to tell your readers that I spoke of "three minutes" in my former rejoinder, merely in allusion to his own assertion that "three minutes *boiling*" would entirely expel free O from water; not meaning to indicate a *minimum* period for the expulsion of O by CO_2. I have, in fact, found no difficulty in proving that thirty seconds, or less, suffices to expel free oxygen from water, by agitation with CO_2. That I have claimed to effect "instantaneously" an action which, like all processes involving solution and effervescence, must occupy some small period of time, is purely another figment of the lively imagination of my antagonist.

I do not doubt that your readers will hold me excused for declining to follow further this really trivial, and so far altogether unprofitable, controversy; until my assailant shall have, at least, proved his "well-known fact" to be upon the record. Supposing it possible for him to do so, he then, in originally denying the fact, as he did most distinctly and unconditionally, must himself have denied what was "well known."

That he has cultivated this dangerous faculty, indeed, to the extent of incipient aberration, might almost be suspected, from the singular style of reasoning that pervades his last note. Thus: In the first paragraph, he asserts that he has applied my method "unsuccessfully;" while thrice, in his third, sixth, and last paragraphs, he complains of my delay in communicating my method to the public—of which he is one. My method, as he has "applied it unsuccessfully," has, doubtless, no existence, except in his imagination, which he may mistake for memory; and the claim he sets out with—that the memory of *one hearer* of a chiefly oral "communication to the members of a scientific body in public session, is equivalent to a publication," and justifies published "critical remarks"—will certainly strike your readers as a rather mischievous maxim to follow, one which were "better honored in the breach than in the observance."

When he *has* done this, I shall, as cheerfully as may be, acknowledge, perforce, what will then have become matter of demonstration, my own similar unfamiliarity with the record.

Hoboken, March 15, 1875.

CHEMICAL NOTES.

BY T. T. MORRELL.

Estimation of Sulphur in Ores.

In the estimation of sulphur in ores, when chlorate of potash or bromine is added to the hydrochloric acid used to effect the solution, they rapidly weaken the acid, and, if the ore is of difficult solution, render the operation very tedious.

In such cases I have found the following arrangement useful: Dissolve the ore in hydrochloric acid, in a flask having a Welter's safety tube for the admission of acid, and an escape tube for the gases, but fused into the glass of the flask, and the mouth, which should be small, provided with an accurately ground glass stopper. The escape tube should dip down into a small flask containing an oxidizing mixture, or, better, a solution of potassa in which a little oxide of zinc is dissolved.

When the decomposition is complete, heat strongly,

and pour gradually through the safety tube a solution of chlorate of potassa. This will oxidize any separated sulphur, and the gases passing over will oxidize any sulphur which has been detained by the alkaline solution. The alkaline solution may then be made slightly acid, and added to that in the other flask, and the whole, after being sufficiently boiled, is treated as usual.

Colorimetric Standards.

In Eggertz's color test for combined carbon in steel, glass standard colors are much to be preferred. When these cannot be obtained of the proper tints, the common brownish-yellow glass (tinted with oxide of silver) may be used inside test-tubes with enough carmine solution to hit the exact color.

The same combination may be used to match the color of solution of iodine in iodide of potassium. The solution itself, however, keeps extremely well if hermetically sealed, and is very useful.

Many chemical reactions with iodide of potassium result in the liberation of iodine. When the solution is dilute, or the quantity is large (testing peroxide of iron in ores, or chlorine in bleaching powder), it is more accurate to titrate; but when the conditions are the reverse, the amount is best determined by color, and the results for very small quantities are as close as in the best gravimetric methods.

In all cases as little free acid as will answer should be present. And the same precaution is necessary if Bunsen's method is used colorimetrically, or chloride of tin is added to a solution of iodine in iodide of potassium and the loss of color noted.

The same standard may be used for Nessler's test.

When phospho-molydate of ammonia (for the estimation of 0·20 per cent. or less of phosphorus), is treated by this test, the color is a shade redder, but it is still very suitable. As the solution in this case must be dilute, large test tubes (1¼ inch diameter), should be used for the comparison of color.

For a bromine standard, a little bromine dissolved in distilled water and hermetically sealed, keeps well.

Cambria Iron Works, Johnstown, Pa.,
March 30, 1875.

ON THE DISCOVERY OF A DEPOSIT OF BISMUTH IN FRANCE.

BY M. CARNOT.

Translated by Josephine Chevalier.

Bismuth is one of the rarest metals among those which we utilize, its ores having been met with in very few foreign localities; we had not known until recently of its existence on French soil.

Saxony has had for a long period almost the exclusive monopoly of the workings of its ores; and the price of the metal has been subjected to enormous fluctuations from time to time. After having been valued only at 11 francs, it rose in 1866 to 55 francs per kilogramme, and during the war of 1870 it became almost inaccessible, even for medicinal purposes.

The return of a like crisis to-day is to be less feared, thanks to the workings of bismuth mines in South America; but the danger is still further removed if our own country takes part in the production of the metal. It is with hopes of so desirable a result that I announce to the Academy the discovery of a deposit of bismuth in the centre of France. It does not seem necessary to make known here the circumstances of this discovery, nor the part which I took in it with M. Vény, Engineer in Chief of Bridges and Roads in Carreze. I will limit myself to saying that the work was undertaken in 1867 on a cropping of quartz, where at first we met only with wolfram and mispickel, and some few arseniated and phosphated minerals; at the end of two years, however, it resulted in the discovery of the first mineral of bismuth. Since that time the work has been interrupted from various causes; but has recently been resumed with persevering zeal, and already has given some very interesting results.

The deposit is situated near Meymac (Carreze), south and in one of the ramifications of the gigantic chains which separate the basins of the Vienne and Creuse from that of the Dordogne and its tributaries.

The soil, where the work was commenced, is of porphyritic granite, of black mica, and of large crystals of feldspar, inclosing nests of radiated tourmaline, granite not very solid, with deep ravines caused by the action of water.

The vein of quartz, which incloses the minerals, appears through a gigantic rock of fine grained and white mica, becoming in places of a greenish color and unctuous to the touch.

Numerous mineral specimens were found in the croppings of this vein. Tungsten presented itself in important masses near the surface; little by little it gave place to the tungstate of lime and hydrated tungstic acid.

Bismuth appeared under different forms, notably under the native form of the metal, in the forms of sulphide, oxide, and hydrocarbonate.

These minerals were accompanied by mispickel in abundance, by small quantities of molybdenum sulphide, also pyrites and hydrated oxide of iron. I should finally state that some minerals of lead, the carbonate, the sulphate, the chlorophosphate, and the molybdenate, were found.

Some of these minerals differ very sensibly by their external characteristics and chemical composition from specimens previously known; they are, therefore, entitled to a special description. I will first mention in few words, the mode of treatment followed in the extraction of bismuth.

The hydrocarbonate is the only mineral of bismuth found in any considerable quantity near the surface of the soil, up to the present time.

It results, without the least doubt, from the alteration of the sulphide, and it is this last ore that we should expect to meet in predominant proportions; but at first it was only a question of utilizing the oxidized ore.

Recent analysis of this ore shows the presence of a small quantity of arsenic, antimony, lead, iron, and lime; it is mixed with gangue, quartz, and various silicates.

After some experiments in the laboratory, I thought that the process of direct reduction in the dry way must be abandoned, as giving place to too great a loss; I then applied the following method:—

Having reduced the ore to a coarse powder, it was treated with hydrochloric acid; the unattacked residue was subjected to a second operation of a similar kind,

and to a third, from which it comes completely exhausted. The action is promoted by stirring the substance occasionally with a wooden spatula and gently heating in earthen vessels.

It becomes almost saturated by metallic oxides which it dissolves, while, on the other hand, after this metallic exhaustion, the residue contains no appreciable quantity of bismuth, neither under the form of unattacked oxide nor under the form of dissolved oxide retained between the particles of undissolved sand. The liquor, which is but slightly acid, is filtered, and iron bars are introduced into it, which completely precipitates the bismuth in a state of black heavy powder. It is separated from the solution charged with salt of iron, without leaving time for these to become oxidized by the action of the air, nor to produce a deposit.

It is washed with water, and received on a cloth and compressed in the form of cakes, which are rapidly dried in a drying stove, in order that the damp and finely subdivided metal, as it is obtained by precipitation, does not undergo oxidation. The dry powder is then packed in a crucible, which is finished by filling with coarsely powdered charcoal; the crucible is then covered and gradually heated for three-quarters of an hour without passing beyond red heat, so as not to produce a sensible volatilization of the metal. The melted bismuth is then run into moulds where it takes the form of bars, in which form it can be delivered for commercial purposes.

The metal thus obtained retains a small quantity of arsenic, lead, and antimony. Further precipitation is accomplished by ordinary processes when it is to be employed for the preparation of the subnitrate of bismuth for pharmacy. This mode of treatment, which is far removed from the processes used elsewhere for the extraction of bismuth, appeared to me to be appropriate, from the actual nature of the ore, and at the same time to the peculiar conditions of workings. It is decidedly economical, and, above all, it allows of no loss of the precious metal, while the operations in the dry way give place to important losses of a metal so readily volatile and which passes so easily into the slags in a state of oxide and silicate.

It furnishes the metal in a tolerable pure state and reduces to a minimum the expenses and losses.

This process has furnished 250 kilogrammes of bismuth, the most of which was sent to the Central Pharmacy of France and employed in the manufacture of the subnitrate.

I will now describe some of the minerals that I found in the excavation, notably those containing bismuth or tungsten. They differ in many respects from analogous specimens found in other localities. I will begin by the minerals of bismuth.

Bismuth Sulphide.—Bismuth sulphide of Meymac is distinguished from the ordinary sulphide which we meet with in collections (bismuthine) by its lead-gray slightly bluish color, which gives it the appearance somewhat of antimony sulphide. Its texture is fibrous, frequently rayed and at the same time laminated, owing to the existence of an easy cleavage which presents quite a brilliant metallic lustre.

This mineral breaks easily, following a second direction sensibly inclined to the first; but this fracture is irregular and of fibrous appearance, not bright enough to admit of an exact measurement of the angles of its two surfaces. Finally a third cleavage is produced perpendicular to the preceding two, which it is natural to consider as parallel to the base of the prism.

I frequently notice at the surface of masses of bismuth sulphide very apparent striations corresponding to the edge of the base.

The specific weight of the pure mineral is 6·60; it melts in the flame of a taper; before the blowpipe and on charcoal it readily gives an incandescent globule, which gives off sparks, the product of which leaves a melted oxide of a yellowish-brown color; it is not sensibly attacked by hydrochloric acid, but readily by nitric acid and with effervescence.

Its composition is the following:—

Bismuth	78·80
Lead	0·75
Copper	0·40
Iron	0·53
Antimony	0·85
Sulphur	14·25
Gangue	0·90
Arsenic	3·10
	99·58

The mineral does not contain tellurium nor selenium; few specimens show traces of cobalt.

These results, confirmed by a series of analyses made on specimens chosen as pure as possible, lead to a formula essentially different from that which we attribute to bismuthine (Bi_2S_3). The proportion of sulphur is much less; the composition of this mineral would be expressed by the formula,

$$46BiS + 2(Pb,Cu_2,Fe)S + 3(Sb_2.As)S_3;$$
$$\text{or, } 16(Bi,Pb,Cu_2,Fe)S + (Sb_3,As)S_3.$$

The bismuth sulphides of Meymac might then be considered as a new variety, presenting with bismuthine differences analogous to those pointed out by M. Wehrle between the tellurides of bismuth.

Bismuth Hydrocarbonate.—This mineral, found abundantly enough in the vein stone, is produced by the alteration of the sulphide of bismuth by atmospheric agents. It preserves the half-fibrous, half-laminated structure of the primitive mineral; its color varies from a gray of a more or less dark shade to a greenish-gray or yellowish-brown; it is sometimes mottled, more rarely of a uniform gray. The fracture frequently shows a brilliant cleavage, and sometimes the mass is white and earthy, though the fibrous texture is always visible. The density is not of absolute constancy. On divers specimens, I found it comprised between 6·81 and 7·25. I can safely say that it is always superior to that of the sulphide, from which it originates as a product of oxidation, a fact which agrees well otherwise with the hypothesis of a transformation on the spot. The powder is white or of a light gray. Heated in a tube it gives off water. Heated in a capsule, it takes, while remaining pulverulent, an orange tint; after cooling, it becomes of a pale reddish color.

At a higher temperature, the substance is completely fused and of a red color. The mineral is readily attacked by acids with effervescence. It is rapidly dissolved by hydrochloric acid, the solution is of a yellow color; and is decomposed by water, giving rise to an abundant precipitate of bismuth oxychloride.

Analysis gives the following results of specimens which by their external appearance may be classed under three distinct heads:—

I. Greenish-white, somewhat laminated; powder greenish-white, density = 6·94.

II. Dark-gray, sometimes greenish; powder gray, density = 7·26.

III. White, earthy, partly yellowish; powder white, density = 7·08.

	I.	II.	III.
Oxide bismuth	89·75	87·50	86·90
" lead	0·55	0·44	0·40
" copper	traces		
" iron	0·53	0·50	0·43
Lime	0·35	0·55	0·38
Oxide magnesium	traces	0·07	0·05
Sulphuric acid	0·25	0·22	0·13
Arsenic	0·73	0·80	0·65
Antimony	0·57	1·25	1·20
Hydrochloric acid	0·37	0·20	0·14
Carbonic anhydride	3·74	4·15	5·35
Water	2·76	3·55	3·02
Gangue	0·20	0·30	1·10
	99·80	99·53	99·75

These results, agreeing with other points, show the difference in the proportion of the carbonic anhydride and water compared with that of the oxide of bismuth. Other analyses confirm this observation. It does not seem necessary to cite here these analyses; they gave from 86 to 90 per cent. With a certain quantity of bismuth oxide the following proportions of carbonic anhydride and water:—

Carbonic anhydride	6·43	5·96	3·74	4·15	5·35	4·82	5·14	3·57	5·35
Water	1·94	2·54	2·76	3·50	2·40	3·13	4.86	4·50	3·02
	8·37	6·50	6·50	7·65	7·75	7·95	8·00	8·07	8·37

If we compare these results with those found by Lampidius,* for *bismuth ochre* of Schneckenberg by Rammelsberg;† and by Genth,‡ for *bismuthite* of South Carolina, we see that together they form a series, the divers terms of which should be applied to one specimen only. Consequently, a narrow formula, like that given by Rammelsberg,

$$[3Bi_2O_3(CO_2+HO)+Bi_2O_3HO]$$

will not suffice, as Genth already suggested, to represent the variable composition of specimens of that variety.

But we can substitute a similar, but more general formula, such as the following, in which the parameter m is susceptible of taking any value:—

$$Bi_2O_3(CO_2+HO)+mBi_2O_3(HO,CO_2).$$

In other words, I think that the mineral should be considered as formed of a mixture in variable proportions of hydrocarbonate—properly speaking, with the hydrate or carbonate of bismuth.

Native Bismuth.—The native metal occurs in irregular and fragile masses of crystalline fracture, laminated, white, with a brilliant lustre; after exposure to the air it takes a reddish hue.

Analysis has given per hundred parts—

Bismuth	99·00
Lead	0·41
Iron	0·10
Antimony	0·15
Arsenic	0·09
Sulphur	0·06
	99·81

Bismuth Oxide.—Native bismuth is ordinarily in compact masses, adherent at the surface. This substance, which is nothing else than bismuth oxide slightly hydrated and carbonated, has a density of 9·22, almost equal to that of the metal itself. It is opaque, half vitreous, of conchoidal fracture. The color is generally of a clear, greenish-yellow; it becomes brown in spots. It is quite hard, but frail and brittle, being easily reduced to a powder of a greenish-gray color. It is soluble in hydrochloric acid; it melts before the blowpipe, and readily gives, on charcoal, a metallic button. Heated gradually in a capsule it successively becomes yellow, orange, brown; and after cooling it takes a pinkish-orange tint. Heated to a higher temperature it melts to a red liquid, which solidifies in the form of a yellow, vitreous mass. Its chemical properties are similar to those of the hydrocarbonate. The following is the composition:—

Oxide bismuth	96·70
" lead	0·55
" iron	0·16
Sulphuric acid	0·15
Arsenic	0·13
Antimony	0·22
Hydrochloric acid	0·20
Carbonic anhydride	0.68
Water	0·95
	99·74

The formula corresponding to the proportion of bismuth oxide, water, and carbonic anhydride would be—

$$12Bi_2O_3+CO_2+HO.$$

We can consider the substance as being formed of bismuth oxide mixed with the hydrate and carbonate, and write

$$2Bi_2O_3+Bi_2O_3(HO,CO_2),$$

Or, in a more general way,

$$Bi_2O_3+nBi_2O_3(HO,CO_2).$$

This mineral is somewhat analogous to the one found by Dr. Jackson with Virginian tetradymite, and to that mentioned in the *Fichtelgebirge*, and analyzed by Luckow—

$$Bi_2O_3—95·5,Fe_2O_3,3HO—2·0,AsO_5—1·5.*$$

It differs very much, on the contrary, by its composition and by its density, from *bismuth ochre*, analyzed by Lampidius—

$$Bi_2O_3—86·4,Fe_2O_3—5·1,CO_2—4·1,HO-3·4;$$
density = 4·36.

I think that this last compound, which Dana has distinguished by the name of *bismite*, should be united to the hydrocarbonate or *bismuthite*. The name *bismite* would then be reserved for bismuth oxide proper.

Mispickel.—A last mineral specimen in which I found a certain quantity of bismuth, is a mispickel, which occurs abundantly enough at Meymac, and which is always associated with bismuth sulphide. The external appearance and chemical properties of this mineral are, for the most part, those of ordinary mispickel. The fracture is at first white; after exposure to the air it frequently assumes a rose tint. Further, by a little care, we can, by means of the blowpipe, distinguish cobalt in this mineral. Analysis of a number of specimens gave the following variable results. Here are three examples—I., a mass; II. and III., fragments of crystalline appearance:—

* Lampidius, Handbuch für Chemische Analysen, p. 286.
† Annalen der Physik und Chemie von Poggendorff, t. lxxvi.
‡ American Journal of Science and Arts, t. xxiii. p. 426.

* Luckow, die Verwitterungun Mineralreische, p. 14.

	I.	II.	III.
Iron	31·90	30·21	28·71
Bismuth	1·62	4·13	6·58
Lead	1·10	traces	0·10
Cobalt	0·16	0·76	1·07
Antimony	1·70	1·90	1·50
Arsenic	40·15	39·96	39·30
Sulphur	16·34	15·90	14·60
Gangue	6·10	4·92	5·70
Water	1·93	2·22	2·44
	100·00	100·00	100·00

The gangue is of quartz and hydrated silicate of alumina, and lime, and magnesia, which is partially attacked by acids; traces of silver and gold were also met with in this mineral.

I supposed, at first, that the presence of bismuth was due to the fine dissemination of the sulphide of that metal in mispickel; but repeated analyses of specimens, where I tried in vain to distinguish the sulphide, showed a sensible quantity of the metal from other sources.

The presence of cobalt, the proportion of which varies with that of bismuth, and in the same sense, at the expense of the proportion of iron, seems to indicate that we have to do with a true combination, mixed, perhaps, in variable proportions with ordinary mispickel.

This combination is probably not without some mixture in specimens II. and III., though they have a crystalline appearance. It would, then, be rather premature to represent it by a mineralogical formula. Finally, we reach the compounds of tungsten, which form three mineral specimens, which are wolfram, calcareous scheelite, and hydrated tungstic acid.

Wolfram.—Wolfram is in laminated masses of easy and bright cleavage. We have not as yet observed any well-formed crystals. It is not as dark nor as bright as wolfram of Zinnwald (Bohemia), or that of Puy-les-Vignes and of Vaulry (Haute Vienne). Its powder is also of a paler brown. It is not magnetic. Its density, taken in mass on a large fragment, was found to be 6·54. The fracture presents dull and brown spots, irregularly distributed. Its powder agglomerates, and sometimes loses considerable weight by the action of heat. The following are the results obtained by the analysis of specimens which seemed unaltered, and dark, brilliant, of large cleavage, giving a brown powder:—

	I.	II.
Tungstic acid	74·75	74·25
Protoxide iron	16·17	15·85
" manganese	6·40	6·51
Lime	0·40	0·80
Magnesia	0·17	0·04
Tantalic acid	0·95	1.10
Quartz, clay, etc.	1·12	
Water		0·70
	99·96	99·25

We perceive that the quantity of tantalic acid is about the same in this mineral as in wolfram found near Chauteloube (Haute Vienne), analyzed by M. Damour. As exceptions, some fragments contained as much as 5 per cent. of tantalic acid. The quantity of tungstate of iron ($FeOWO_3$) and tungstate of manganese (MnO,WO_3) contained in wolfram of Meymac, are in the proportions of 5 to 2.

Scheelite.—The tungstate of lime is found in crystalline masses of vitreous lustre, and a little admixture of a gray or brown color. Its fracture is laminated, and frequently presents irisations. Its powder is grayish-white. I found its density 5·80, and for its composition by analysis of two specimens—

	I.	II.
Tungstic acid	74·50	74·20
Lime	18·70	18·84
Oxide iron	1·05	1·51
Manganese	0·30	0·35
Tantalic acid		0·40
Gangue (quartz)	5·20	4·24
	99·75	99·54

The relative proportions of the essential elements answer to the formula CaO,WO_3.

Hydrated Tungstic Acid.—In various localities scheelite takes a yellow or greenish color, still retaining its crystalline structure and cleavages; otherwise the transformation appears complete. The mineral is friable between the fingers; it is of a yellow or brown color, and it has a resinous lustre. It is essentially formed of tungstic acid, but it also contains water and a certain quantity of lime and oxide of iron. Heated gradually, its powder passes from a light-yellow to an orange-brown; then it takes a darker tint, almost black, and agglomerates. Heated in a tube it gives off water; before the blowpipe, on charcoal, it rapidly becomes black; with phosphorous salt in the outer part of the flame it gives a yellow bead, which is almost colorless in the cold. In the inner part of the flame the bead becomes purple or red, colorations due to the presence of the oxides of iron and tungsten. Ammonia acting on the powdered substance, partially dissolves the tungstic acid and lime; the residue becomes colorless, but resumes its pale-yellow tint when treated with nitric acid, by the dissolving of the oxide of iron. The color is decidedly yellow when treated with nitric acid; dirty-green when treated with hydrochloric acid. If we add to the hydrochloric acid liquor a fragment of zinc, it immediately gives, under this reducing influence, a blue coloration very characteristic. Since hydrochloric acid alone does not produce this blue coloration on the mineral, due to a lower oxide of tungsten, and that hydrogen is not given off, as Ebelmen has already observed for wolfram, we may safely conclude that tungsten does not exist in this substance at a lower degree of oxidation than tungstic acid. Analysis gives the following composition for specimens of variable appearance: I. and II.—Friable substances, of a yellow or brown color; powder of a sulphur-yellow; density = 3·50 to 3·80. III.—Laminated substance; powder yellowish; density = 4·45.

	I.	II.	III.
Tungstic acid	71·85	74·25	75·12
Tantalic acid	1·00	1·05	0·70
Lime	2·50	4·65	7·00
Oxide iron	6·00	6·10	6·25
" manganese	0·75	0·65	0·32
Water	12·93	11·75	6·85
Gangue (quartz, mica, clay)	4·50	1·85	2·55
	99·53	100·30	98·79

I further observed, in some fragments, traces of magnesia and potassa, the presence of which should, without doubt, be attributed to a mixture of silicates, par-

tially attacked by the acids. This mineral, which it seems has not been met with up to the present time elsewhere than in the Meymac deposit, must have resulted from the alterations on the spot of scheelite. If we make a deduction of the numbers having reference to the tungstate of lime and hydrated oxide of iron, which we suppose exist in a state of simple mixture in this mineral, the remaining proportions of water and tungstic acid correspond very nearly to the following:—

$$WO_3,2HO \text{ or } 2WO_3,5HO.$$

I propose to resume the analyses, in order to fix more definitely the mineralogical formula of this substance. From the beginning we see that by external appearance and chemical composition, the minerals which I have just described present a difference too striking with anhydrous tungstic acid, pulverulent, earthy, or in small cubic crystals, such as has been described up to the present, to permit of our confounding them in a single instance. If we reserve the name *tungstite* for the anhydrous tungstic acid, which is given to it by some mineralogists (*Dana*, p. 186), we could, from its source of production, name the hydrated tungstic acid *meymacite*. Some typical specimens of different minerals found in this locality will be presented to *l'Ecole des Mines.—Annales de Chimie et de Physique.*

A NEW TREATMENT OF COMMERCIAL NICKEL, TO OBTAIN SULPHATE OF NICKEL, WITHOUT USING HYDROGEN SULPHIDE OR AMMONIA.

BY A. TENEIL.

Translated by E. H. S. Bailey, Ph.B.

In the recent use of nickel for plating considerable quantities of salts of nickel are consumed, and these salts have been prepared almost exclusively from commercial nickel, which is a triple alloy of nickel, copper, and iron, with small quantities of arsenic. The proportion of nickel varies in this alloy from 40 to 90 per cent., and we have been accustomed to separate copper and arsenic from an acid solution by hydrogen sulphide, then the iron, after peroxidation, by an excess of ammonia. The result of the operation is an ammoniacal salt of nickel, from which it is difficult to eliminate all the ammonia.

A new treatment is proposed which does away with the use of sulphide of hydrogen and ammonia, and gives, very economically, pure sulphate of nickel. Four operations are considered: 1. Solution of the commercial product in acids. 2. Precipitation of the copper by iron. 3. Peroxidation of the iron and transformation of the metals into sulphates. 4. Precipitation of the iron by carbonate of baryta, and crystallization of sulphate of nickel.

1. The nickel is dissolved by attacking it with seven or eight times its weight of aqua regia. Afterwards it is evaporated almost to dryness, and the residue dissolved in about five times as much water as the original nickel taken. Complete solution is obtained, with the exception of a little arseniate of iron, which can be separated by filtration, but which may, without detriment, be allowed to remain.

2. Into the warm solution about as much metallic iron (small nails are preferable) is introduced as the nickel taken at first, and the solution is agitated from time to time to detach metallic copper. This precipitation of copper, which takes place very rapidly, is shown to be complete when a bright piece of iron plunged into the liquid remains clean and bright.

To separate the copper the solution may be decanted upon a filter, and the residue, after being washed several times, may be sifted under water in a sieve with meshes large enough to allow the copper to pass through, but to retain the iron. This copper can then be disposed of as an article of commerce.

3. The liquid separated from copper contains nothing but nickel and iron, the latter being in the state of protoxide. After peroxidation, either by a current of chlorine gas or by nitric acid, the two metals are transformed into sulphates by the addition of commercial sulphuric acid, at 66°, in the proportion of two parts of acid for one part of nickel originally employed. The solution is then evaporated to dryness to drive off hydrochloric and nitric acids, and the residue again dissolved in water. A part of the iron often remains as an insoluble subsulphate, but this is of no consequence, as the sulphate of nickel is entirely dissolved.

4. Iron is precipitated from the solution by means of carbonate of baryta obtained by precipitation. The iron is separated as sesquioxide, and insoluble sulphate of baryta is also formed, while the sulphate of nickel remains unchanged. The last traces of arsenic that might still remain are also precipitated with the iron. This precipitation takes place best if to the slightly-warmed solution, *i. e.*, not above 50° or 60°, carbonate of baryta is added gradually till it is slightly in excess. When this reagent causes no more effervescence, and no more iron is precipitated, the process is considered complete. After filtration pure sulphate of nickel remains in the filtrate, and, if it is evaporated till a pellicle forms on the surface, upon cooling, crystals of the pure salt may be obtained.—*Bulletin de la Société Chimique de Paris.*

CHEAP ELECTRICITY.

BY W. H. WALENN, F.C.S.

It is a popular belief among the unscientific that there is nothing that cannot be done by electricity. A certain class of inventors seem to have the same idea, and any difficulty that defies other means of solution is presumed to be overcome or able to be successfully combated, by this wonder-working power. Some endeavor to make out that the sole obstacle to perpetual motion is removed by it; others believe that its powers of reducing metals are so recondite that it only requires a slight step to adapt it to the discovery of the transmutation of metals; and others, again, look upon electricity as the source whence the very *elixir vitæ* is to be obtained.

Among the purposes to which inventors have sought to apply electricity, such contrarieties appear as blasting rocks, capturing and killing birds; discharging firearms, fertilizing seeds; making mirrors, metallizing a human corpse; transmitting intelligence, destroying vermin. Besides these, many other remarkable applications may be cited, which, for their accomplishment, depend upon the property which electric force possesses of being somewhat readily made to excite other varieties of force, such as motive power, heat, chemical action, magnetism, and light. Motive power, by means of electro-magnetic arrangements, has been accomplished up to four horse power. The heating power of the electric current is shown by the readiness with which

platinum and iron are fused in the voltaic arc of a powerful electrical arrangement. Chemical action, excited by electric force, has been applied extensively in the arts; for instance, electrotypy, electro-plating, and electro-etching. Many more applications remain as scientific curiosities, to be soon raised to the dignity of useful and practical inventions, such as the reduction of metals from their ores, the manufacture of chemical compounds, and the production of various gaseous bodies in a direct manner. The applications of electro-magnetic power are innumerable, and range from the vast systems of telegraphy which at this moment encircle the whole of the civilized, and much of the uncivilized, portions of the earth, to registering the motions of a machine, or winding up an ordinary clock. This portion of the subject appears scarcely developed yet, and when electric power is more easily attainable, will assume giant-like proportions. Twenty or thirty years ago the electric light had only one development, namely, the convective electrical discharge between charcoal points; now it has at least two others, that arising from the ignition of rarefied gas in Geissler's tubes, and the transmission of a continuous electric current through an insufficient carbon conductor inclosed in a non-active gas. The writer is informed that the latter application is likely to totally change the prospects of lighting by electricity, by enabling a number of lights to be placed in the same electric circuit.

At this place the reader will perhaps ask, "What is electricity?" The answer to this question is not so easy to give as it might at first appear, and the writer perfectly recollects hearing a lecture, twenty-five years ago, that commenced with this query, to which the answer was, that we knew nothing about what electricity is, but could only define it as something which produces certain definite effects. This definition is not so unsatisfactory as it seems to be, for many other well-known entities are described, and rendered intelligible and realizable by means of the evidences or manifestations of their existence; for instance, a very fair definition of mechanical force may be drawn from its power to prevent the descent of a weight, or to resist a pressure. According to this method, which appeals to the perceptive or external faculties of the mind, electricity might be described as that which produces heat, light, magnetism, and chemical action. Unfortunately for this view, electricity itself can be produced by means of either heat, magnetism, or chemical action, and perhaps by light;* it is, therefore, desirable that a method should be used to describe, connect, and classify these effects, which appeals to the deeper, more interior, and reflective faculties of the mind. This perhaps can be best accomplished by first of all defining the word force, and then realizing, from that definition, mechanical force, chemical force, and electrical force.

For the purposes of this essay force will be defined, as Professor Grove (now Justice Grove) defined it, in a lecture given at the London Institution, in January, 1842, namely, as a "mode of motion." This view has recently been promulgated by other philosophers (Dr. Tyndall, for instance), and it will tend to elucidate the matter if Grove's own words are reproduced here. He says:† "Physical science treats of matter, and what I shall to-night term its *affections*, namely, attraction, motion, heat, light, electricity, magnetism, chemical affinity. When these react upon matter they constitute forces. The present tendency of theory seems to lead to the opinion that all these affections are resolvable into one, namely, motion: however, should the theories on these subjects be ultimately so effectually generalized as to become laws, they cannot avoid the necessity for retaining different names for these different affections; or, as they would then be called, different modes of motion." We shall, therefore, no longer define electricity as *something* which produces certain definite effects, but as a *force* or mode of motion which may be communicated to particles of matter capable of receiving such motion. Its waves are of such a nature that—when interrupted by a medium which opposes their progress, but which would be able to transmit the undulations entirely if it were large enough—they are converted into heat waves, accompanied by luminous vibrations. If the motion be interrupted by a decomposible fluid, the chemical affinity of the component parts of the fluid is destroyed, and they are conveyed in opposite directions. At right angles to the direction of motion of the electric force, the magnetic force always exists, and its amount and quality (boreal or austral) has direct relation respectively to the amount of the electric force, and to the direction in which it is travelling. Polarization, or that property by which there appear to be opposite qualities in different parts of the same body, or in separate bodies—such as the opposite charges of a Leyden jar, or the contrary electrical condition of the metallic plates respectively, at the extremities of a galvanic battery—is the consequence of the electric waves occurring in definite planes. Further, it appears that electrical wave motion, confined to a given space, as in an insulated but charged conductor, for instance, tends to excite the same kind of wave motion in the opposite direction in a neighboring conductor, and thus to produce the phenomena of electrical induction; in other words, one kind of electric polarity cannot be produced without the production also of the other kind, either in another part of the same body or in distinct bodies. Not only is electric force under specific conditions in each case convertible into heat, chemical force, or mechanical motion, but also, under specific conditions in each case, these forces are respectively convertible into electric force. If, therefore, the undulatory character of any one of these forces be conceded, it follows that electricity is a wave-propagated force, since the method of conversion of one force into another is by changing the character of the wave-motion by which it is propagated.

The classification of electricity as a force among the other forces of nature enables comparisons to be made, analogies to be drawn, and results to be anticipated, which would otherwise have been imperfectly known or wholly undiscovered. The more or less distinct perception of these relations and applications have worked in the brains of inventors, and have produced results more or less practical, the noticeable point in electrical applications, or the uses of electric force, being their diversity, their great range, and the unique character of their mode of action. The one point which has hitherto greatly restricted their general use and appreciation is that—produced from a galvanic battery—the force is dear in comparison with other forces, especially in comparison with heat, the power at present universally employed for mechanical and other work.

The next question that arises is, "Can electricity be produced cheaply?" As remarked above, the most ordinary way of generating, inducing, or producing electric power, is by means of a galvanic battery, an arrange-

* See Grove's "Correlation of Physical Forces." Fourth Edition, 1862, pp. 153, 154.

† See "Correlation of Physical Forces." Preface, p. ix. *et seq.*

ment which involves the destruction of metallic zinc, the employment of powerful and expensive chemicals, and a considerable amount of skilful attention and waste of material, besides two very great inconveniences, namely, the occupation of great cubical space, and the littering and spilling about of chemicals that give forth noxious fumes and promote rust and dirt. For some twenty or thirty years past, electricians have sought to supplant the galvanic battery by the magneto-electric machine, which is free from the above objections. This has been partly accomplished; but there are still some grave objections to the use of magneto-electric machines of the usual kind for the electric light, and for depositing metals, or indeed for any purpose in which an electric current of considerable capacity or quantity is required to circulate in an absolutely continuous stream for a length of time, this being just the quality of the electric power which is supplied by the galvanic battery. In ordinary magneto-electric machines, not only is the current not continuous, but it is induced in jerks or shocks, so that the term shock is a much more suitable word for the intermittent electric power produced by these machines than the term current, the shock occurring at the instant that the core of the coil giving the current undergoes the greatest change of magnetism, and resists the motion most strongly; the method of approximating the quality of this kind of current to that of the galvanic battery, is to rotate the coils so quickly that the duration of time between the intermittences is reduced to the smallest possible amount, but this necessitates the undue expenditure of mechanical power. Another, and still more serious objection to the ordinary magneto-electric machine is that the shocks are produced from the machine alternately in opposite directions; therefore, in order to derive useful work from this kind of electricity, it is necessary to reverse every alternate shock by means of a complicated and uncertain apparatus called a commutator. This reversal is never in practice so perfectly accomplished that none of the induced currents or shocks are lost or neutralized, for the electric power has to pass from revolving contact pieces to fixed metallic springs, and in so doing either leaps across the contact pieces or else burns the springs. The losses from the commutator only, may therefore be said to be: 1st. By dissipation of electric power. 2d. By neutralization from imperfect insulation of the contact pieces. 3d. By the reflex or opposite extra current induced in the coils at the time of making or breaking the electrical circuit. The most serious difficulty, however, in ordinary machines, is that the heat generated by the reflex and waste currents enlarges the axis of the machine, and tends more and more powerfully to stop it as it is driven faster, so that the maximum speed with which it can be driven with economy constantly decreases during continuous use. Again, in consequence of the waste of electric power, when a quantity of electricity is required, and when therefore large and heavy coils are used, these are made larger and heavier than they otherwise would be, to make up for the waste, thereby using up still more mechanical force or engine power to drive them than if they gave forth all the currents induced in them in a useful form.

The state of electric power described in the last paragraph has caused many inventors to search for a method of inducing continuous and uninterrupted electric currents in the magneto-electric machine itself, but for many years this desideratum eluded their grasp, and its possibility has been doubted by many. This result is said to be perfectly attained by Gramme's machine. This machine does not depend upon the increase or decrease of magnetic polarity, or upon the change of magnetic polarity, to induce the electric current, as all former machines have done; it simply depends upon the fact that if one pole of a permanent magnet be moved parallel to a long, cylindrical electro-magnet, the opposite magnetic polarity induced in the core of the electro-magnet, during the travel of the permanent magnet in one direction, will induce an electric current in the conducting wire which is of constant power, continuous, and without intermission during the motion of the permanent magnet in the same direction along the electro-magnet. To enable the current to be really continuous, and not to stop when the pole of the magnet has arrived at the extremity of the electro-magnet, the core of the electro-magnet, is made annular, or ring-shaped, and it is wound in a continuous coil that is composed of a series of coils having blades that proceed to an axis in the centre of the annulus. Fixed springs take off the currents from the neutral points of this travelling electro-magnet. Thus, an equable and continuous current is obtained without the necessity of a reversal of any kind.

The importance of this realization can scarcely be over-estimated, for zinc (the destruction of which in the galvanic battery yields electric force) is 20 times the cost of coal, weight for weight, and 200 times the cost of coal for equal quantities of potential energy.* Gramme's machine depends principally upon coal, either in the form of a gas-engine or of an economical steam-engine, for its current cost; there is no heating beyond that due to the ordinary friction of bearings, and all the motive power conveyed to it is said to be utilized, because none of the induced electric currents are found to have been dissipated, neutralized, or opposed. Should the expectations held out by the new machine be realized in practice, it may not be long before the reduction of metals from their ores, the deposition of the common metals and alloys, and the obtainment at a cheap rate of chemical substances, the more recondite gases, and of artificial light itself, on a far grander scale than any that has been hitherto realized, become accomplished facts.—*Journ. of Soc. Arts.*

DIVISIBILITY OF QUICKSILVER, GOLD, AND SILVER.

The Virginia *Enterprise* says: "The divisibility of quicksilver, and also of silver and gold, as shown by the mining operations conducted in this State, is almost incomprehensibly great, and would seem to be almost illimitable, particularly in the case of the metal first named. A globule of quicksilver may be divided until no longer visible to the naked eye, and indeed scarcely visible under a powerful microscope, yet even the most minute subdivisions shall be found to contain silver or gold, perhaps both. How infinitesimally small, then, must be the particles of silver or gold contained in one of these invisible and immeasurable globules of mercury! In regard to the astonishing divisibility of the metal mentioned, we have just learned some interesting facts of Dr. Buncher, Superintendent of the Rock Point Mill, Dayton. This gentleman informs us that some time since, when working in his mill for a considerable period an ore in which gold largely predominated, he used every precaution to guard against loss. In addition to the usual settling tanks, he caused to be dug in the ground a number of large pits, into which the waste

* See Fleming Jenkin's "Electricity and Magnetism," p. 296.

water flowed after leaving the tanks. After leaving these pits, the water passed off in a small flume, and to the eye appeared as clear as the water of the purest mountain stream. For the sake of experiment, Mr. Buncher coated a copper bowl with quicksilver, and placed it in such a position that the water of the flume should fall into it. He also placed in the flume, below the bowl, some copper riffles, properly coated with quicksilver. Although the water passing through the flume seemed to be perfectly clear, yet at the end of three months the bowl and riffles were cleaned up, and over $100 worth of amalgam obtained. His mill is driven by water from Carson River, and carried for a considerable distance through a large wooden flume. A month or two since it became necessary to shut off the water and repair a portion of this flume. In making the necessary repairs it was found that in many places the heads of the nails driven into its bottom had been thickly coated with amalgam. Within the distance of about three rods along the bottom of the flume the workmen engaged in making the flume collected over an ounce of amalgam. This was where there were no copper plates or other special facilities for catching the floating particles of quicksilver. The water flowing through the flume was taken from the river below a number of large mills, and, though far from being clear, would never have been suspected of containing floating quicksilver in such quantities as to amalgamate the heads of iron nails. In order to amalgamate iron, it must be scratched or polished while immersed in quicksilver; therefore it will be seen that much material must have passed by before the occurrence of the accidents required for the commencement of the accumulations found on the nails. As another evidence that quicksilver in considerable quantities floats in the water of flumes and streams below reduction works in a state of invisible division, and yet carries with it the precious metals, Dr. Buncher gave us this additional evidence: On a certain occasion one of his workmen required a piece of copper. Remembering to have seen some old sheets of that metal lying near the waste-gate of the main flume, he went to the spot, and hauled them out of a puddle in which they were lying, and found them heavily coated with amalgam, and so eaten up that they were hardly thicker than writing paper. The water pouring out through the waste-gate had a fall of about fifteen feet. It did not fall directly upon the copper plates, but in such a manner as to keep them constantly splashed and wet. Mr. Buncher thinks the plates had lain in the place four or five years. Over a pound of amalgam was scraped off them. It appears to us that in these several striking instances of the treacherous and unsuspecting floating away of the precious metals, there is for millmen food for reflection, and for inventors a field in which to reap both profit and distinction."—*Mining and Sci. Press.*

THE OXYHYDROGEN BLOWPIPE OF DR. R. HARE, 1802.

BY B. SILLIMAN.

In my address before the Chemical Centennial Gathering, at Northumberland, Pennsylvania, in August, 1874, I gave a somewhat detailed account of Dr. Hare's Oxyhydrogen Blowpipe, quoting portions of his memoir from *Tilloch's Magazine* (xiv., 1802). It is rather remarkable that so important a paper as this of Dr. Hare's should never have been printed in any American scientific journal, and that we should have been compelled to quote it second-hand from the pages of *Tilloch's Magazine*, to which it was communicated by the author from the imprint of the original paper, printed for the Chemical Society of Philadelphia. I sought in vain for a copy of this *brochure* at the time of preparing my address, but I have lately, thanks to the kindness of Mr. M. Carey Lea, found a copy in the Library of the American Philosophical Society of Philadelphia, which by the liberality of Prof. Lesley, the Librarian, has been placed in my hands for consultation. It is No. 18 of Vol. 52, "American Tracts," a series of rare and interesting fragments, partly scientific, preserved in the collections of the Society. This copy is addressed to "Dr. Barton with assurances of the regard of his friend and quondam pupil, the author," and is authorized by McVaughan, the former well-known Librarian and Secretary of the Philosophical Society, whose bachelor breakfasts, in the Society's rooms, some of us remember with pleasure as among the attractions offered to literary and scientific visitors in Philadelphia forty years ago.

I have thought that a reproduction of the more important portions of this "Memoir" by Dr. Hare, would not fail to interest your readers at this time. The original paper covers 34 pages, and is divided under four chapters and an Introduction. As this introduction contains some facts of historical interest in the history of American chemical science not generally known, it is proper to cite it in full:—

"INTRODUCTION.

"On the 24th of October, 1801, a committee, of which I was a member, was appointed by the Chemical Society, for the discovery of means by which a greater concentration of heat might be obtained for chemical purposes.

"The committee thus appointed, soon after informed the Society, that, as they had conceived, the only way of attaining the object of their appointment would be to precipitate more copious supplies of oxygen gas into any focus of combustion; they had therefore confined their attention to the exhibition of a machine by which this would be much facilitated.

"This machine had been previously invented by me; and I was induced by the recommendation of my colleagues to subject it to the attention of the Society.

"The Society honored the report of the committee with a favorable reception; ordered them to produce an engraving of the machine; and that this, together with the explanation of it, should be laid before the public.

"These commands of the Society would have long since been complied with, but that experiments suggested themselves, the execution of which demanded time. Some of these experiments appear to invalidate the opinion, that the precipitating of larger supplies of oxygen gas, into any focus of combustion, would be the only way by which the intenseness of caloric would be increased to a degree not before attained.

"On the 10th of last December, I informed the Society of my having conceived, that a more intense heat might be obtained by the united combustion of hydrogen, oxygen, and carbon, than had been before produced; and I, at the same time, laid before them an improvement of my machine, which tended much to facilitate the application of the hydrogen and oxygen gases to this joint combustion.*

* Extract from the minutes of the Chemical Society, of the 10th of December, 1801.

"Mr. Hare then called attention of the Society to some improve-

"Still continuing my experiments on that subject, I was afterwards enabled to produce to the Society, fused specimens of native lime and pure magnesia; and to inform them that barytes, alumine, and platina were susceptible of rapid fusion.

"An account of these and other experiments on the supply and application of the blowpipe, together with an engraving and an explanation of the apparatus by which they were effected, are the subjects of the following paper."

Dr. Hare does not inform us who his "colleagues" on the Committee of the Chemical Society were, nor does it appear that this Society issued any volume of transactions, or a journal. Indeed this tract is the only one of their publications which I have seen, although others may exist. This introduction fixed December 10th, 1801, as the date when the discovery of Mr. Hare was first publicly announced.

The full title of Dr. Hare's Memoir is as follows:—

"MEMOIR on the SUPPLY AND APPLICATION of the BLOWPIPE, *containing an account of a new method of supplying the Blowpipe either with common air or oxygen gas; and also of the effects of the intense heat produced by the combustion of the Hydrogen and Oxygen Gases.*

"ILLUSTRATED BY ENGRAVINGS. Published by order of the Chemical Society of Philadelphia, to whom it was presented by ROBERT HARE, JUN., Corres. Mem. of the Society."

"Philadelphia: Printed for the Chemical Society by H. Maxwell, Columbia House, 1802."

Chapter I. of this paper treats of the "important uses of the blowpipe. Imperfections of the means hitherto employed for supplying it with air. Mention of a machine free from these imperfections."

Chapter II. is an "explanation of an engraving of the hydrostatic blowpipe—account of the manner and principle of its action."

Chapter III. treats of the "application of the hydrostatic blowpipe to the uses of the mouth blowpipe and to the purposes of the enameller's lamp—manner of supplying it with the gases, and of applying it to the supply of combustion with oxygen gas."

It is evident that Hare was led to the use of oxygen and hydrogen gases in his hydrostatic blowpipe by a natural induction, in his efforts to improve a previously existing instrument. The engraving which accompanies his memoir exhibits two cooper's casks, each provided with bellows for the injection of air or any gas into the space formed by a horizontal and vertical diaphragm, in a way sufficiently familiar to render its reproduction here needless. Having described his apparatus in detail, and dwelt on its fitness to repeat the experiments of Lavoisier in supporting the combustion of carbon with oxygen gas, Hare next treats, in Chapter IV., of "Evils experienced in operating with the combustion of carbon and oxygen gas; superior heat of combustion supported by the hydrogen and oxygen gases; its effects on the most refractory substances.

"To avoid these evils, it was thought desirable that means might be discovered of clothing the upper surface of any body which might be subjected to this species of operation, with some burning matter, of which the heat might be equal to that of the incandescent carbon, with which the lower surface might be in contact; or by which bodies might be exposed on solid supports to a temperature equal or superior to that of the porous charcoal uniting with oxygen.

"It soon occurred that these desiderata might be attained by means of flame supported by the hydrogen and oxygen gases; for it was conceived that, according to the admirable theory of the French chemists, more caloric ought to be extricated by this than by any other combustion.

"By the union of the bases of the hydrogen and oxygen gases, not only is all the caloric of the oxygen gas evolved, but also a much larger quantity, which must be necessary to give the particles of the hydrogen their superior power of repulsion. The product of this combustion is water in the state of steam, which retains heat so slightly that it acts merely as a vehicle to deliver it to other bodies. What is necessary to preserve to water its form of fluidity, is the only portion of caloric extricated in this combustion which is permanently abstracted.

"The combustion of carbon with oxygen gas has been hitherto considered as the hottest of all fires. The caloric evolved in this case proceeds of air, without any possibility of mixture. One of these compartments being supplied with oxygen and the other with hydrogen gas, two common brass blowpipes were joined at their orifices to two tubular holes in the conical frustrum of pure silver, of which the mean diameter is one-third, and the length three-fourths of an inch. The diameter of one of these holes is large enough for the admission of a common brass pin. The other hole is a third less. They commence separately on the upper surface of the silver frustrum near the circumference, and converge so as to meet in a point, at the distance of a line and a half from the lower surface. In the space between the lower surface and the point of meeting, there is a perforation of the same diameter as the larger hole. The manner in which this perforation and the tubular holes communicate one with the other may be understood from the lines in the form of a letter Y in the transparent representation of the silver conical frustrum. The pipes were then fitted into the mouths of the pipes of delivery (Fig. 1), so that the blowpipe inserted into the larger hole of the frustrum should communicate with the compartment containing the hydrogen gas, and that the other should communicate with that which contained the oxygen gas. The cock of the pipe communicating with the hydrogen gas was then turned until as much was emitted from the orifice of the cylinder as, when lighted, formed a flame smaller in size than that of a candle. Under this flame was placed the body to be acted on, supported either by charcoal or by some more solid and incombustible substance. The cock retaining the oxygen gas was then turned until the light and heat appeared to have attained the greatest intensity. When this took place the eyes could scarcely sustain the one from the oxygen gas alone, while the product of this combustion is carbonic acid gas, which abstracts the large quantity of caloric necessary to give it the form of air, but which adds nothing to the heat of the combustion. Hence it is evident that more caloric is evolved and less abstracted in combustion supported by the hydrogen and oxygen gases than in that supported by oxygen gas and carbon.

"However the intenseness of the heat of combustion is not only dependent on the quantity of caloric extricated; but also on the comparative smallness of the time and space in which the extrication is accomplished.

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ments in his newly invented Hydrostatic Blowpipe, by which he was enabled to exhibit the combustion of the hydrogen and oxygen gases; the heat produced thereby being very intense.—J. H., *Recording Secretary.*"

But in this respect the aeriform combustible has obviously the advantage over those which are solid, as its fluid and elastic properties render it susceptible of being rapidly precipitated into the focus of combustion, and of the most speedy mixture with the oxidating principle when arrived there.

"The opinion of the intenseness of the heat produced by the hydrogen and oxygen gases, thus upheld by theory, derives additional support from the practical observation of the great heat of a flame supported by hydrogen gas while issuing from a pipe; and also of the violent explosion which takes place when it is mixed with oxygen gas and ignited; for it appears that this explosion can only be attributed to the combination of an immense quantity of caloric with the water, which is either held in solution by these gases, or formed by the union of their bases.

"Such was the reasoning which originated the desire of employing the flame of the hydrogen and oxygen gases. But before this could be accomplished, it was necessary to overcome the difficulty of igniting a mixture of these aeriform substances without the danger of an explosion. It was for the purpose of surmounting this difficulty that the hydrostatic blowpipe was furnished with two compartments, by means of which the machine might be at the same time charged with different species, nor could the most refractory substances resist the other.

"However, it is worthy of notice that the light and heat of this combustion do not become evident until some body is exposed to it, from which the light may be reflected, or on which the effect of the heat may be visible. This is not the case with combustion supported by oxygen and carbon; for no sooner is a stream of oxygen gas directed on ignited carbon than an effulgence is produced, which impresses the mind of the beholder with an idea of the greatest heat being produced by it.

"It is in this different appearance of these different species of combustion that we may discover the reason why philosophers have neglected the one while they have bestowed much attention on the other."*

It will not escape the notice of the attentive reader that it required neither discovery nor invention to enable any person to apply Dr. Hare's apparatus and discovery to the production of a powerful light, and hence the so-called Drummond light or calcium light is nothing more than Hare's compound jet placed in the focus of a parabolic mirror. He specifically states that the light and heat of the focus, which the eyes could scarcely contain or the most refractory substances resist, do not become evident until some body is exposed to it from which the light may be reflected, etc., and he certainly used lime and magnesia in this focus, which he finds "extremely difficult to fuse." It was ten years later than this, viz. in 1812, that Prof. Silliman published his account of "Experiments on the Fusion of Various Refractory Bodies by the Compound Blowpipe of Dr. Hare, burning hydrogen and oxygen gas" (*Am. Phil. Soc. Phila.*, iii. p. 328), in which he greatly extended the original observations of Dr. Hare. It is the more interesting, therefore, to see what Dr. Hare says in his original memoir on this subject. We quote his language (pp. 30–34, *loc. cit.*):—

"I shall now describe the changes effected on the most fixed and refractory substances by the flame of the hydrogen and oxygen gases.

"By exposure to the gaseous flame, either on supports of silver or of carbon, barytes, alumine, and silex were completely fused.

"The products of the fusion of alumine and silex were substances very similar to each other, and much resembling white enamel.

"The result of the fusion of barytes was a substance of an ash-colored cast, which after long exposure sometimes exhibited brilliant yellow specks. If it be certain that barytes is an earth, these specks must have been discolored particles of the silver supports, or of the pipes from which the flame issued.

"Lime and magnesia are extremely difficult to fuse, not only because they are the most refractory substances in nature, but from the difficulty of preventing them from being blown on one side by the flame; nevertheless, in some instances, by exposure on carbon to the gaseous flame, small portions of these earths were converted into black vitreous masses. Possibly the black color of these products of fusion may have been carried by iron contained in the coal; for in the high temperature of the gaseous flame a powerful attraction is reciprocally exerted by iron and the earths.

"Platina was fused by exposure on carbon to the combustion of hydrogen gas and atmospheric air. But the fusion of this metal was rapidly accomplished by the gaseous flame, either when exposed to it on carbon, or metallic supports.

"A small quantity of this metal in its native granular form, being strewed in a silver spoon, passed under the gaseous flame, the track of the flame became marked by the conglutination of the metal, and when heat was for some time continued on a small space, a lump of fused platina became immediately formed.

"About two pennyweights of the native grains of platina, when subjected to the gaseous flame on carbon, became quickly fused into an oblate spheroid as fluid as mercury. This spheroid, after being cooled, was exposed as before. It became fluid in less than a fourth of a minute.

"Had I sufficient confidence in my own judgment I should declare that gold, silver, and platina were thown into a state of ebullition by exposure on carbon to the gaseous flame, for the pieces of charcoal on which they were exposed became washed or gilt with detached particles of the metal in the parts adjoining the spots where the exposure took place. Some of the particles of the metal thus detached exhibited symptoms of oxidation.

"As the fusion of lime and magnesia by exposure on carbon was accomplished with great difficulty and uncertainty, it became desirable that means might be discovered of effecting this fusion with greater ease.

"By the union of the base of oxygen with iron the whole of the caloric of this elastic fluid is supposed to be extricated. This consideration, together with some practical remarks on the heat of burning iron, induced me to employ the combustion of this metal in conjunction with that of the hydrogen and oxygen gases.

"Some pieces of iron wire, each of about half an inch in length, were quickly thrown into fusion and rapid combustion by exposure on carbon to the gaseous flame. When either lime, magnesia, barytes, alumine,

* The inferiority of the light emitted by the flame of the hydrogen and oxygen gases to that which irradiates from bodies exposed to its action, adds one to the many instances in combustion in which the quantity and color of the light extricated do not seem to be so much dependent on the quantity of oxygen gas consumed, as on the nature of the substances treated or burned. In this, therefore, we may find support for the idea that the light extricated by fire, or emitted by heated bodies, proceeds not only from the decomposition of pure air, but from that of the combustible or the heated bodies themselves.

or silex were thrown on the iron in this state, they became instantly melted and incorporated with the metal. It remains a question whether the substances which resulted from their union with the iron were mixtures or combinations. If they were combinations, according to the present nomenclature, they should be denominated *ferrurets*.

"The difficulty of igniting some substances which are only susceptible of combustion at very high degrees of heat has hitherto excluded them from the laboratory. By means of the gaseous flame such substances may be employed with the greatest facility in small analytical operations.

"Of the nature of the substances above described are the carburets of iron and some peculiar species of native coal.

"Among the carburets of iron the English plumbago is esteemed the best. Some pieces of this substance, obtained from the best English black-lead pencils, were readily thrown into combustion by exposure to the gaseous flame, either on carbon or on some larger pieces of American plumbago. It was found that either lime or magnesia was fusible when exposed to the fire thus produced. This, however, may have been caused by the iron contained in the carburet, for the fused earths and plumbago generally adhered to each other.

"There is a peculiar species of native coal found on the banks of the Lehigh, in this State, which is extremely difficult to ignite; but when exposed to a high degree of heat and a copious blast of air, it burns yielding an intense heat without either smoke or flame, and leaving little residue. By exposure to the gaseous flame on the coal both magnesia and lime exhibited strong symptoms of fusion. The former assumed a glazed and somewhat globular appearance. The latter became converted into a brown semi-vitreous mass."

Fully to appreciate the work performed at this early day by Hare, we must remember that he had scarcely passed his twentieth year when his hydrostatic blowpipe was contrived, and that he was only twenty-one when he made his memorable discovery of the intense heat produced by the combustion of hydrogen in oxygen, and that he has been chiefly his own teacher in chemistry. At that time Berzelius was practising medicine at Stockholm, and giving lectures on chemistry. Not having then commenced those researches which made chemistry an exact science. Priestley was still fighting the last battles of phlogistics from his quiet retreat at Northumberland. Volta's pile had been made known in London to Sir Joseph Banks only a few months before (February, 1800), and had not yet been exhibited by command of Napoleon I. before the French Institute. Its electro-chemical powers had just been discovered by Nicholson and Cartrite in the decomposition of water, but this discovery had not yet been made a principle of classification by Berzelius (1803). And Davy was still busy in his experiments on the inhalation of gases at the Pneumatic Institute of Dr. Biddoes. There was not then a laboratory of chemical research in America, and hardly one in England. Hare and Silliman uniting to fit for themselves a working place in Mrs. Smith's cellar kitchen, on the corner of Walnut and Dock Streets, in Philadelphia, where the experiments with the oxyhydrogen blowpipe were jointly continued.* Hare drew his inspiration, to use his own expression, from "the admirable theory of the French chemists," and chiefly from Lavoisier and Chaptal. His method of reasoning upon the phenomena of heat and of combustion, was very much in advance of the science of the times, and was evidence of his power of philosophic comprehension. In the "Address" before mentioned, my reasons are given for assigning to Hare a prominent place in the list of original discoverers, and these reasons need not be repeated here.

The modest suggestion he throws out of the probable volatilization of gold, silver, and platina in the focus of his "gaseous flame" became not long after a certainty to him in his subsequent researches in Voltaic electricity when by means of his "deflagrator" he gave wings to these metals in a way which left no doubt of the reality of the vaporization.

His remark about "a peculiar species of coal found on the banks of the Lehigh, which it is extremely difficult to ignite," is curious reading in these days when anthracite coal has attained such vast proportions as a natural industry. But it was twenty years after that time before there was a commencement even of the development of this great factor of power, which has since reached an annual consumption of nearly twenty millions of tons.

If the Chemical Society of Philadelphia did no more than to give the world Hare's Memoir on the Oxyhydrogen Blowpipe, it well deserves to be remembered as the pioneer society for the promotion of chemical studies.

New Haven, March, 1875.

* Life of B. Silliman, by Fisher, i. 103.

ON NOXIOUS AND OFFENSIVE TRADES AND MANUFACTURES, WITH ESPECIAL REFERENCE TO THE BEST PRACTICABLE MEANS OF ABATING THE SEVERAL NUISANCES THEREFROM.*

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Amongst the nuisances defined in the various Acts of Parliament, general and local, are those occasioned by the operations of trade and industry. Sections 27 and 28 of the Amended Nuisances' Removal and Diseases' Prevention Acts (18 and 19 Vict. c. 121) express in a general way the character of these nuisances and the methods of procedure in cases of default, "If any candle-house, melting-house, melting-place, or soap-house, or any slaughter-house, or any building or place for boiling offal or blood, or for boiling, burning, or crushing bones, or any manufactory, building, or place used for any trade, business, process, or manufacture causing effluvia, be at any time certified to the local authority by any medical officer, or any two legally qualified medical practitioners, to be a nuisance or injurious to the health of the inhabitants of the neighborhood, the local authority shall direct complaint to be made before any justice, etc., for the suppression or mitigation of the nuisance complained of;" and by the Sanitary Act, 1866 (29 and 30 Vict. c. 90, s. 18), a like power of initiating proceedings is given to any ten rate-payers of the place in which such nuisance exists, on a requisition in writing to the local authority. In case of such procedure, it is necessary not only to show that the trade or business complained of "is a nuisance, or causes effluvia injurious to the health of the inhabi-

* A paper read before the Society of Medical Officers of Health, on January 16, 1875.

tants of the neighborhood," but also that the person complained against has not "used the best practicable means for abating such nuisance, or preventing or counteracting such effluvia."

It follows, therefore, that the supervision of such trades and manufactures, and the maintenance of them in such condition as that the best practicable means are constantly used to prevent the escape of offensive effluvia, forms one of the most important duties of the medical officer of health; and as, in a professional capacity, I have had occasion frequently to visit and inspect most of the manufactories belonging to this category, I have thought that a brief account of my experience in the matter might be acceptable to my professional colleagues.

And here I ought to state that on entering upon any inquiry of this description, it is proper to keep in mind the evident intentions of the legislature, namely, the maintenance of the public health and comfort with due regard for the necessities of industry; for it will be observed, that although the preservation of the public health has been considered by Parliament of such paramount importance as to justify enactments containing enormous arbitrary powers, yet the exercise of those powers is always guarded with such provisos as will prevent abuse, and thereby unnecessary injury to trade. It is fortunate that, in most cases, the interests of the public and the manufacturer, although apparently conflicting, are really in accordance; for that which is injurious to the public is frequently a wasteful loss to the manufacturer; and therefore the prevention of such waste by reasonable contrivances has a double advantage. This may not be apparent at first sight to the chief parties interested, for it has often happened in the course of my professional practice that the suggestions which I have offered for the mitigation of a nuisance have not been readily accepted by the manufacturer, although in the end they have been gratefully acknowledged. I cannot, indeed, too strongly impress upon the minds of all who are concerned in such inquiries, that there need not be a feeling of antagonism in the matter; for if at any time it exists, it is either caused by a want of confidence in the skill and technical knowledge of the professional adviser of the local authority, or by an unjust and exaggerated view of the necessity for providing for the public health and comfort at all costs. This is manifestly in opposition to the spirit of the Acts of Parliament, so far as local authorities are concerned; for their duties are to see that the best practicable or available means are adopted to prevent the escape of noxious or offensive effluvia. If that fails to abate the nuisance complained of, the parties aggrieved have their remedy at law or in equity in one of Her Majesty's superior courts. On the other hand, as Mr. Keane observes, the manufacturer is bound to use the best practicable and available means to protect the public from annoyance or injury to health. It will not be enough to adopt such precautions only as are used in the place or district among persons carrying on the same business or manufacture, if it has been ascertained that there are better which are available; and in interpreting the words available and practicable, it is probable that the magistrates will pay more attention to scientific than pecuniary difficulties. It is of great importance, therefore, that the opinions of the medical officer of health should be well founded, and his recommendations free from reasonable objections, for it must not be forgotten that the manufacturer, if he thinks himself aggrieved, has the right and power of appeal from the justices to a superior court, where the knowledge and judgment of the medical officer will be severely tested.

But besides the nuisances which are caused by manufacturing operations, there are others which are more or less incidental to them, as well as to other branches of trade and industry, "Any accumulation or deposit which is a nuisance or injurious to health; or any pool, ditch, gutter, or watercourse, so foul as to be a nuisance, or injurious to health" (18 and 19 Vict. c. 121, s. 8); or "any factory, workshop, or workplace, not already under the operation of any general Act for the regulation of factories, or bakehouses, not kept in a cleanly state, or not ventilated in such a manner as to render harmless, as far as practicable, any gases, vapors, dust, or other impurities generated in the course of the work carried on therein, that are a nuisance or injurious to health;" and "any fireplace or furnace which does not, as far as practicable, consume the smoke arising from the combustible material used in such fireplace or furnace;" and "any chimney (not being the chimney of a private dwelling-house) sending forth black smoke in such quantity as to be a nuisance" (29 and 30 Vict. c. 90, s. 19)—all of which are under the supervision of the medical officer of health, with a view to legal proceedings in case of default.

Looking at the individual peculiarities of these nuisances, it is evident they may be conveniently classified under three heads, namely:—

1st. Those which are caused by the escape of noxious or offensive effluvia, as gases and vapors.

2d. Those which are produced by smoke, dust, or other mechanical impurities.

3d. Those which are occasioned by the discharge of noxious or offensive matters into gutters, ditches, or watercourses.

It will not be possible to discuss in a satisfactory manner the whole of these subjects in this paper, and therefore I propose to limit your attention to the first of them, namely, to those trade nuisances which are caused by the escape of noxious and offensive effluvia, as sulphuretted hydrogen, empyreumatic or other organic vapors, and the gaseous acids.

Foremost of those operations which cause offence by the escape of *sulphuretted hydrogen* into the atmosphere is the manufacture of *sulphate of ammonia* from gas liquor. This liquor is produced in great quantity at the gas-works—varying from 10 to 40 gallons per ton of coals, according to the strength of the liquor and the perfection of the processes for removing ammonia from gas. The strength of the liquor is estimated and expressed by its gravity in degrees of Twaddell, or by the number of ounces of strong sulphuric acid (sp. gr. 1·850) required to saturate a gallon of it. This varies from 5 or 6 ounces per gallon to 25 ounces, and, according to my experience, the proportion of sulphuretted hydrogen contained in it ranges from 230 grains, or rather less than one-third of a cubic foot per gallon, to rather more than 1250 grains, or nearly 2 cubic feet per gallon; so that the liquor is exceedingly offensive from the quantity of sulphuretted hydrogen contained in it; and therefore it is necessary to store it in air-tight tanks, and to transport it from place to place in air-tight vessels—as barrels or tank-barges, or tank-trucks. It is proper also that the orifices which give exit to the air at the time of filling the tanks should be guarded with a box or small barrel containing hydrated oxide of iron, which absorbs the sulphuretted hydrogen, producing sulphide of iron which is subsequently revived by the action of the air.

The methods of treating this liquor with sulphuric acid so as to produce sulphate of ammonia have differed at different times and places. In my early experience, even in this metropolis, the process was to neutralize the liquor with brown acid of specific gravity 1·720, and to convey the evolved gases into a furnace fire, as their escape into the air would be dangerous to the workmen; and the saturated liquor still reeking with sulphuretted hydrogen was evaporated in open lead troughs over open fires. The nuisance arising from these operations was absolutely unbearable; and as people got to be more and more sensitive of annoyance, the old process was discontinued. At the present time the practice is to evaporate or distil the liquor from closed boilers or chambers, and to convey the volatile products—ammonia, carbonic acid, and sulphuretted hydrogen—into a closed chamber, or saturator, containing weak sulphuric acid, there being a contrivance for the escape of carbonic acid and sulphuretted hydrogen, and the conveyance of them to a furnace fire. In some cases the liquor is distilled from boilers set over a common fire; but, as this is liable to flushes and irregularity in working, it is objectionable, and has given place to the process of distilling by means of a steam coil set in the boiler, by which steam at from 20 to 30 pounds pressure is blown into the liquor. But the best contrivance of ail is that known as Coffey's still, which consists of a vertical chamber from 20 to 25 feet in height, having a series of transverse septa which alternately leave an opening at their ends. In this way, with about sixty of such septa, a superficial area of about 1000 square feet of evaporating surface may be obtained. The liquor is delivered in a constant and graduated stream at the top of the chamber, and as it flows backwards and forwards in a descending current over the transverse septa, it meets with an ascending blast of steam which is let into the bottom of the chamber at a pressure of from 15 to 30 pounds. In this way the volatile constituents of the liquor are carried over to the saturator, where the ammonia is arrested by sulphuric acid, and the exhausted liquor flows out in a continuous stream from the bottom of the chamber. The saturator is generally an air-tight, leaden vessel, about 4 or 5 feet square and 3 or 4 feet deep, containing a charge of diluted sulphuric acid—equal parts of chamber acid (1·600) and water. When the acid is saturated with ammonia, which is known by test-papers, steam alone is blown into it from the still for about half an hour to displace all traces of sulphuretted hydrogen, and the solution is drawn off into open pans or troughs, where it is evaporated by means of a closed coil of high pressure steam set in the solution.

Another kind of saturator occasionally in use is a leaden vessel divided into two compartments by a diaphragm or curtain, which descends below the liquid to within about 18 inches of the bottom. One of these compartments is closed air-tight, and receives the volatile products of the still, where they meet with a graduated stream of brown acid (sp. gr. 1·720), which continually neutralizes them, and forms crystals of sulphate of ammonia, which are constantly ladled out of the open compartment. The apparatus is ingenious, and saves much labor and time in evaporation, as the acid is used in its undiluted condition; but it is not so certain or satisfactory in its action as the closed saturator before described.

In both cases the uncondensed gases—sulphuretted hydrogen and carbonic acid—with much steam, are conveyed from the saturator through a 4-inch pipe to the furnace fire, where the sulphuretted hydrogen is burnt. It is necessary, however, that the sulphuretted hydrogen should be deprived of its moisture before it reaches the fire, or it will extinguish it; and this is effected by throwing the pipe into coils, or otherwise cooling it. The precautions, therefore, to be taken in the conduct of this business are:—

1st. The transport and storage of the gas liquor in air-tight tanks, guarded with boxes of hydrated oxide of iron.

2d. The distillation of the liquor in a steady and continuous manner in air-tight stills by means of high pressure steam.

3d. The saturation of the ammonia in close vessels, and the complete expulsion of sulphuretted hydrogen from the saturated solution before it is drawn off for evaporation.

4th. The condensation of moisture from the sulphuretted hydrogen evolved from the saturator, and the conveyance of the cold dry gas to the furnace fire, where it is to be completely burnt.

5th. The treatment of the exhausted liquor from the still with cream of lime, so as to recover the residual ammonia by a second distillation; or, if the process be in operation at a gas-works, the use of the residual ammonia as an absorbent in the purification of gas.

6th. The observance of the greatest care as regards the tightness of all parts of the apparatus.

Another operation which demands care in its management is *the distillation of coal tar* for the various products derivable from it. There are two kinds of tar obtained from coal, according as the temperature of distillation is high or low, and according to the richness of the coal in hydrocarbons. One is ordinary coal tar, and the other is the tar from which paraffin oils are obtained. The tar produced from common coals at a high temperature (common coal tar) is always heavier than water (sp. gr. 1·120 to 1·150); it dries freely in the air by oxidation; it contains hydrocarbons with such an excess of carbon that they cannot be burnt in a common lamp; it is almost entirely destroyed by strong oil of vitriol; it contains much sulphur, and its percentage composition is about 86 carbon, 7 hydrogen, 6·5 oxygen, and 0·5 sulphur. Whereas the tar produced from cannel coal at a low temperature is lighter than water (sp. gr. about 0·900); it will not oxidize or dry in the air; it contains hydrocarbons of the paraffin series, which are comparatively poor in carbon, and which can be burnt in a lamp; it is not much acted on by oil of vitriol; it contains little or no sulphur; and its percentage composition is about 84 carbon, 12 hydrogen, and 4 oxygen. Both of these tars are the subjects of technical manipulation, and if not properly managed are the cause of nuisance, as are also the processes used in their primary production. In dealing with ordinary coal tar, it is proper that it should be stored and carried in air-tight tanks, and left covered with a little water. The delivery of it into tank-barges or tank-trucks, and from them into the tanks of the works, should be by means of pumps and air-tight flexible hose; and the openings of the barges and tanks should be guarded with a box containing hydrated oxide of iron, as in the case of ammoniacal liquor.

The distillation of coal tar is always conducted in iron stills set over a naked fire; the stills are of varying capacity, from 1200 to 5000 gallons, and the crown of them is always protected with brick-work to keep them hot, so that the later volatile products may not cool and condense and fall back into the still. The time of

the distillation of a charge is from twelve to fifteen hours, according to the capacity of the still; and the products are first condensed in a worm or pipe kept cool in water, and then received in a specially contrived box (varying in form or construction at different places) which permits the several products to flow away by separate pipes (four or five in number, and each provided with a tap) to their several tank receivers. This box is made air-tight (its cover being guarded by a water valve), and it is provided with an ascending pipe, which carries the foul gases to proper purifiers before they pass into the furnace shaft. The gases which are evolved during the process of distillation are, first sulphuretted hydrogen from the ammoniacal liquor which always accompanies the tar, then gaseous or uncondensible hydrocarbons, and finally the acrid vapors of the superheated pitch, with an abundance of sulphuretted hydrogen. These gases and vapors should be made to pass first through a vertical condenser or scrubber charged with a stream of cold water, and then through an oxide of iron purifier with two or three trays of oxide, and finally to the furnace shaft. The necessary draft for these operations should be secured by means of a fan, or by the aid of the furnace shaft. It is proper to mention that unless there is a draft of considerable power, the unavoidable leakage from the constantly loosening joints of the pipes will not be prevented. It is right also to state that it is dangerous to convey these gases and vapors into a furnace fire, as they are explosive when mixed with air, as they necessarily will be.

The products of the distillation of coal tar vary in different places. At one time they were but four, namely: First, ammoniacal liquor and very light naphtha, which come over before the tar in the still begins to boil. Second, a crude naphtha which floats upon water, and is therefore called "light oil." Third, a creosote oil which sinks in water, and is called "heavy oil;" and fourth, the residuum, which is a soft pitch. At present, however, in well-conducted works, the creosote or dead oil is run off in two portions, namely, an early portion, consisting of creosote and heavy naphtha, which is used for burning in furnaces; and a later portion, which is best suited for the preservation of timber. This is followed by a greenish oil, which is sometimes collected apart, and redistilled with the anthracene oil that runs from crude-pressed anthracene; and then follows a green oil (anthracene oil), which is allowed to flow until it gets very thick from the presence of chrysene, the residuum in the still being hard pitch. It is in the later stages of the process, when the high temperature of the still causes the decomposition of the pitch, that sulphuretted hydrogen and acrid vapors are evolved; and this also is the cause of the nuisance from the hot pitch when it is run off from the stills into open pits. To guard against this, it is proper that the fire should be raked out from under the stills directly the process is over, and the pitch should remain in the stills to cool for ten or twelve hours; it should then be run into close receivers, or into a properly constructed chamber, and allowed to cool for twenty-four hours before it is discharged into the final receiver. All these should be ventilated, so as to convey the vapors through the scrubbers and purifiers before mentioned. An excellent form of receiver for the pitch from the stills is a long air-tight chamber, which will bear internal pressure, and which communicates at the bottom with an outside trough, into which the cool pitch is forced by the weight of the hot pitch at each time of its discharge from a still. The pitch, when cooled to a temperature of about 180° or 190° Fahr., may be freely exposed to the air, and be either run into pits or ladled out into moulds.

It may be interesting to know that the approximate yield of the several products per 1000 gallons of coal tar is as follows:—

Crude and light oil, sp. gr. ·940 to ·970,	from 24	to	40	gals.
Creosote oil,	" 1·060 " 1·070, " 120	"	180	"
Anthracene oil,	" 1·080 " 1·095, " 100	"	160	"
Pitch, which melts at 176° Fahr.,	3·2	to	3·6	tons.

These products are again submitted to further operations, for the purpose of getting benzole, toluole, light-burning and solvent naphthas, carbolic and cresylic acids, creosote for fuel and for timber, and anthracene; but the processes are not generally offensive, and therefore need not engage much of our attention, although a brief outline of them may be useful. The light oil is redistilled from stills with steam jackets or with closed coils, or by blowing steam into it. That which flows up to a gravity of 0·940 is put aside for benzole and solvent naphtha, and the remainder is used for carbolic acid. The naphtha thus obtained is purified by treating it with strong sulphuric acid; after which it is washed with lime-water, and distilled for benzole and solvent naphtha. The heavier naphtha and the first runnings of creosote are washed with a solution of caustic soda for carbolic acid, which is subsequently separated from the alkali by neutralization with acid; and the green anthracene oil is allowed to stand until quite cold, when the crude anthracene separates from it in granular particles. These are strained off through canvas bags, and pressed in hydraulic or screw presses, whereby the crude anthracene of commerce is obtained. The approximate yield of each of these several products is:—

From crude naphtha and light oil, from	6 to 10	per cent.	tar acid.
	20 " 28	"	benzole.
	10 " 15	"	solvent naphtha.
Creosote oil,	10 " 15	"	carbolic acid, etc.
Anthracene oil,	10 " 12	"	crude pressed anthracene.

For the purpose of increasing the yield of anthracene and its congener chrysene, the distillation of the pitch is sometimes carried on until a spongy coke remains in the still, and under these circumstances the acridity of the evolved vapors is most offensive, and requires the utmost attention to prevent their becoming a nuisance to the neighborhood. The main points, therefore, to be observed in the conduct of works of this description are:—

1st. The transport and storage of the coal tar in air-tight tanks or vessels guarded with boxes containing hydrated oxide of iron.

2d. The proper construction of the primary receiver of the products of distillation, so that it may freely deliver them by special pipes to their respective receivers, and at the same time convey offensive non-condensible products to the scrubbers and purifiers.

3d. The passage of the offensive non-condensible gases and vapors to a scrubber charged with a douche of cold water; then through an oxide of iron purifier, and finally to a tall chimney shaft.

4th. The proper cooling of the pitch in air-tight vessels before it is allowed to reach the external atmosphere, and the ventilation of these vessels through the scrubber and purifier before mentioned.

5th. The use of a fan or other exhausting power, so as to draw all the noxious gases and vapors from the stills, the pipes, the receivers, and the pitch den,

into and through the scrubber and purifier before mentioned.

The production of paraffin oil from cannel coal, and the distillation of the crude tar, as well as the distillation of petroleum and Rangoon oil, requires like precautions, though not to the same extent, as the products are not nearly so offensive as in the case of coal tar products.

Dead oil, or creosote, is largely employed for preserving timber; but unless there is great carelessness in the management of the operations, they are not offensive. The process is conducted in the following manner: The timber to be creosoted is placed in iron cylinders of great strength and capacity; and when the end opening is closed and well secured with screws, the interior of the cylinder is exhausted by means of an air pump until there is a vacuum of about 5 inches of mercury. This is maintained for nearly half an hour, during which time the contents of the cylinder are heated by steam pipes. In this manner the air and moisture of the wood are drawn out of it, when dead oil is allowed to run into the cylinder until it is full. The heat is continued, and pressure is put upon the contents of the cylinder until it reaches to from 100 to 150 lbs. upon the square inch. This is maintained for many hours—the time varying from 4 to 12 hours, according to the nature of the work; in most cases the amount of creosote absorbed by the wood ranges from 40 to 50 gallons to the load of 50 cubic feet. The oil is then run out, and when sufficiently drained the timber is ready for delivery. Hardly any precaution is necessary beyond that of preventing the unnecessary escape of creosote oil and vapor.

Dead oil is also used as fuel, and there are two ways in which it has been successfully employed. In one case the oil is converted into vapor in a specially contrived boiler, and the vapor is burnt as fuel. In the other the creosote is delivered from a jet immediately over a steam jet, and as the creosote trickles down from the upper jet it meets the blast of steam which blows it as a fine spray upon a bed of glowing cinders or ashes. In this manner it produces a sheet of flame of great heating power. A ton of creosote, which is about 210 gallons, is equal to about two tons of ordinary coals; but the management of the jet or stream of creosote is rather a delicate operation, as an excess of the oil produces an immense volume of smoke, with the acrid irritating odor of the unburnt oil.

Before leaving the subject of these hydrocarbons, I may state that the *melting of pitch and asphalte* for the production of materials suited for the making of asphalte pavements, etc., is in the generality of cases a very offensive operation. All sorts of pitchy matters, as the residuum of paraffin oil (technically called "shellgrease"), Trinidad bitumen, various natural asphaltes, and coal-tar pitch are melted in small iron boilers set over naked fires. The boilers are but loosely covered, and during the melting and mixing, to produce the material called "bitumen," large volumes of irritating and offensive vapors escape into the air. The bitumen thus produced is, in some cases, again heated with powdered asphalte in specially constructed boilers having a mixer moved by machinery; and in this case offensive vapors are freely evolved. The charge when thoroughly incorporated and melted is called "mastick," and is drawn off into pails, and cast in moulds for use where the pavement is to be laid. All these operations should be conducted in closed boilers, which should be ventilated by a fan through a scrubber prior to its entrance into the chimney shaft.

The clarification of oil for burning and other purposes is generally effected by means of sulphuric acid, which is well stirred into it. After the black flocculi, formed by the action of sulphuric acid upon impurities, have subsided, the oil is further clarified by means of water and steam, the latter being blown into it until it reaches a rather high temperature; and during this part of the operation the oil is kept in gentle agitation by means of stirrers so as to favor the separation of the oil from water and other impurities. In the case of rape or colza oil, the vapors which are given off are disagreeable and acrid, like mustard, while those of linseed and other oils are also offensive, though in a less degree. Cotton oil is refined by means of a solution of caustic soda, and this also, when subsequently heated by steam, is offensive. The remedy in each case is the carrying on of the operations in closed vessels, ventilated to the furnace fire.

The distillation of oils and fats for the production of stearic, margaric, palmic, oleic, and other fatty acids is effected by means of sulphuric acid and superheated steam. The melted fat is run into vats or boilers, where it is heated to a temperature of about 240° Fahr. At this temperature it receives a dose or charge of strong sulphuric acid, delivered into it as a fine spray, or through perforated copper trays. All this time it is kept in continual agitation by means of stirrers, and this is prolonged for about an hour, during which time a little sulphurous acid and acroleine escape. When the fat acquires a dirty greenish tint the "saponification," as it is called, is complete. Boiling water is then run into the mixture and steam blown through it for about four hours; after this it settles for a couple of hours and the acid watery portion is run off. It is washed a second time with hot water and steam, and when clear it is delivered into the stills for treatment with high pressure superheated steam—the pressure being about 50 lbs. on the inch, and the temperature about 500° Fahr. At this temperature and pressure the fatty acids are distilled over, and are collected in a series of condensers, ending in a worm set in cold water. The first condenser delivers the greater part of the fatty acids with but little water, the second more water and less acid, and so on to the end, where water is the chief product. The water contains glycerine; and the residuum in the stills is a sort of pitch, which is used by the asphalte makers.

In these operations sulphurous acid and acroleine are evolved, so as to be offensive to the neighborhood, unless they are conveyed from air-tight apparatus into the furnace fire.

Oil boiling for making varnishes, linoleum, leather cloth, printers' ink, and black japan, is a very disagreeable operation, and requires to be conducted in boilers, from which the fumes pass into the furnace fire to be distroyed.

Varnish making and rosin distilling are also offensive operations, and necessitate the destruction of the acrid organic vapors by carrying them to the furnace fire, or to fires placed at the outlet of hoods which cover the pans. In cases where inflammable spirit is used to a large extent in certain manufactures, as in making American cloth, the difficulty of dealing with the vapor is exceedingly great, as it is dangerous to pass it through a furnace fire for fear of explosions. In one factory with which I am acquainted, the quantity of petroleum spirit used daily in the thinning of the oil for the colours is not less than 140 gallons—all of which is daily evaporated from the cloth in the drying-room,

which is gradually raised to a temperature of 130° Fahr., at which it is kept for six hours during the drying of the colors. In these cases it is best to ventilate the room freely by special shafts communicating with the chimney at a point where the vapors are not likely to be fired.

Fat melting, *bone boiling*, *tripe dressing*, and *the cooking of sheep's heads*, *bullocks' cheeks*, *livers*, *and feet*, as well as the *boiling of shell-fish*, *lobsters and crabs*, are all offensive operations, and require to be conducted in closed coppers ventilated by special flues, which carry the organic vapors into the fires beneath them.

Akin to these are the processes for making *size* and *glue*. All sorts of gelatinous materials, as fresh English fleshings (cuttings of hides) from tanneries, kip fleshings from abroad, calves' pates, and the cuttings of skins called "hide pieces," dried sinews, sloughs (bones inside horns), with other such offal and garbage, as well as fresh bones, are the raw materials from which size and glue are made. The fresh fleshings, as well as the clippings of others which contain fresh lime, are steeped for several hours in water acidulated with sulphuric acid. Old fleshings, in which the lime is killed by becoming carbonate, are merely washed with water; and these with the other glue-making materials are put into large open boilers, called "glue pans," with water, and are boiled for two or three hours by a naked fire, when glue is made, or by means of a steam coil, when size is the product, until they are dissolved. They are frequently stirred during this operation, in order that the fat may rise for collection. The liquid is then run off through a rough strainer into a tank, and allowed to settle for about half an hour, when it is either put into tubs and sent away as size, or it is allowed to set in wooden troughs, from which it is taken and cut up into blocks about a foot square, which are subsequently further divided by means of a wire into slabs, and dried. The degree of concentration in making size is much less than that for glue, the point in the latter case being determined by the appearance of the cooked liquor upon a lump of alum. The residue in the glue pans is a mass of fibrous matter, called "skutch," which often contains enough fat to pay for another operation. The skutch is put into a boiler with enough sulphuric acid to dissolve the fibre (about 75 lbs. to a ton of skutch), and it is heated by high pressure steam blown into it. Under this treatment the fibre dissolves and so lets loose the fat, which rises to the surface. All these operations are offensive, and require to be managed with great care to prevent them from being a nuisance. The fleshings and other materials, for example, are frequently allowed to remain in heaps in hot weather until they putrefy, and the vapors from the glue pans and the skutch pans are exceedingly nauseous. It is proper, therefore, that the raw material should be used as quickly as possible, or be kept in covered tanks, and the vapors from the covered pans should be conveyed through condensers or coolers, and thence to the furnace fires.

Manure Making.—Apart from the making of superphosphate of lime, which I shall hereafter describe, the manufacture of animal manure is frequently a frightful annoyance, from the circumstance that it is generally in the hands of small capitalists, who have very little regard for the health or comfort of the community. The raw materials are of the most heterogeneous character; as fleshings, breakings, and other refuse from tanners, fellmongers, soap-makers, fat-melters, bone-boilers, glue-makers, etc., together with all sorts of waste from furriers, wool-spinners, hair-dressers, etc.; putrid fish, putrid flesh, and the offal of markets and slaughter-houses; all of which are indescriminately used as the basis of animal manures; and these are treated in vats or boilers with sulphuric acid and steam—there being rarely much provision for the destruction or neutralization of the offensive vapors. Occasionally the operations are conducted in closed iron cylinders set vertically; so that the charge may be dropped into them at the top, and let out at the bottom. When full they are made tight and submitted to the action of high pressure steam (from 30 to 50 lbs.), which is blown into them for ten or twelve hours. In this manner the materials are perfectly disintegrated, and after standing for a few hours to cool, the liquid portions, consisting of water and fat, are first run out through a tap at the bottom, and then the solid parts are removed. Apparatus of this kind can be worked without annoyance to the neighborhood; but if the manufacturer prefers to mix his materials in his own way, it should be done in a close chamber or cylinder with revolving arms, and with a contrivance for carrying the offensive gases to the furnace fire. Other operations, as *fish drying* and *smoking*, and the *preparation of albumen* from *blood* and *eggs*, also deserve notice as requiring attention and cleanliness to guard against nuisances.

Animal Charcoal Burning.—This until lately was a great annoyance to the inhabitants of the neighborhood in which sugar bakers reside. Formerly the bones were burnt in iron retorts set in a furnace, without much precaution against the escape of the offensive empyreumatic vapors; and the red-hot charcoal was cooled and quenched in iron boxes by means of water, whereby much sulphuretted hydrogen was evolved. The processes, however, at present in practice are planned with every consideration for the public comfort. The retorts are so constructed that the vapors from the ignited bones are carefully conducted to the furnace fire and are burnt; and the red-hot bone black is received into specially designated coolers that do not permit of the access of atmospheric air, which would be destructive of the carbon of the bones. When the animal charcoal has become exhausted of its decolorizing power, it is again burnt and revivified in revolving retorts, or in well-designed vertical cylinders, which do not permit of the escape of any offensive matter into the surrounding atmosphere, but discharge it into the furnace fire.

The roasting of coffee, *chicory*, *and cocoa*, if not properly managed, is offensive. The operation is performed in a revolving cylinder or cage set over a coke or charcoal fire inclosed in a tight chamber, which is ventilated to the chimney shaft. In the case of coffee and cocoa the roasting operation is often performed in wire cylinders, whereas that of chicory, on account of the large quantity of powder produced, is always of sheet iron. The cylinders are about 4 feet long and 20 inches in diameter. They receive about a hundredweight at a charge, and they are run into the roasting chamber upon a square axle, which supports them over the clear fire, about a foot above it. They are then set in gear, and turned by machinery at the rate of about fifty revolutions a minute. There are breaks in the interior of the cylinder to distribute the coffee or chicory during the roasting, so as to equalize the action. The operation lasts about thirty or thirty-five minutes for coffee or chicory, and half the time for cocoa; and the empyreumatic vapors go into the fire and up the chim-

ney shaft. When the operation is finished, in the case of coffee and cocoa, the roasted berries are cooled by a blast of air, and this blows about a quantity of the outer covering of the coffee berry (called flights), which are occasionally annoying to the neighborhood. The loss of weight during these operations is from 14 to 16 per cent. for coffee, from 9 to 11 per cent. for cocoa, and about 25 per cent. for chicory. *Brown malt* and *roasted corn* are likewise roasted in much the same manner, and require that the empyreumatic vapors should be carried into the fire and be burnt.

There is another vegetable matter which in burning has lately caused offence to the neighborhood in which the operations are conducted. This is the resinous matter obtained by the evaporation of the alkaline liquor obtained in the treatment of *Esparto grass and straw in paper-making*. The liquor is first evaporated in large close evaporating pans, which receive the full force of the fire above and below, and thus the vapors are carried forward into the chimney shaft. When the residuum is sufficiently consolidated, it is roasted in a furnace, for the purpose of burning off the organic matter and recovering the alkali. This operation has been forced upon the paper-makers in consequence of the difficulty of disposing of the spent liquors. I believe the pasty residuum of the evaporated liquor would be found useful in preventing the scale or fur of steam-boilers.

Within the last ten years a new branch of industry has sprung up in this country, on account of the permission to use sugar as well as malt in the production of beer. The sugar is called *saccharine*, or *glucose*, or *grape sugar*, and it is generally made from the cheapest and most accessible kinds of starch. Rice starch is that which is commonly used in this country at the present time. The rice is crushed between rollers and macerated in a vat with a little alkali for about twelve hours, during which time it is constantly stirred by revolving arms moved by machinery. In this manner the gluten of the rice is dissolved out of it, and the starch is set free. After standing quiet for about six hours the starch settles, and leaves a supernatant solution of gluten, which is generally thrown away. The starch is then transferred to another vat and treated with water acidulated with sulphuric acid. About 150 lbs. of acid (sp. gr. 1·850) and 1500 gallons of water are sufficient for a ton of starch. The mixture is stirred like the last, and it emits a smell of rancid butter and grains (butyric and lactic acids). It is then run into a vertical cylinder, called a "digester," where it is submitted to the action of steam, at 20 lbs. pressure, blown into it for about half an hour. This converts the starch into glucose, and the solution is allowed to flow into a vat, where it is neutralized with powdered chalk, and kept stirred for about two hours, during which time the same offensive smell of butyric and lactic acids is evolved, and to a much greater extent. The clear liquor is next filtered through horsehair bags to separate sulphate of lime, and it is then evaporated in vacuo, to the consistence of a very thin syrup, which is filtered through animal charcoal in the usual way. This is further evaporated in vacuo until it looks like honey. In this state it is poured into moulds and allowed to set. The yield of starch from the rice is as much as 80 per cent., and the yield of sugar is about 5 per cent. above the weight of the starch. The saccharine or grape sugar, when well made, contains from 80 to 82 per cent. of glucose, with only a trace of gum and mineral matter; and it is generally used by the brewer mixed with two parts of malt. The offensive effluvia from these operations are easily prevented by covering the vessels and ventilating them into the fire or chimney shaft.

Leaving these, which are the most important operations whereby sulphuretted hydrogen and organic vapors are evolved, I proceed to a class of manufactures which are nuisances by reason of the irritating acid vapors and gases which they produce; and these may be classified under different heads.

1. *Those which generate muriatic acid gas.* Until comparatively recently (since 1863, when the Alkali Act came into operation), the production of carbonate of soda, or rather salt-cake, which is the first step of the process of manufacture, was one of the most offensive and destructive operations in the kingdom. For a distance of miles, indeed, around the *alkali works*, vegetation was blasted, and residential existence was almost impossible. Action upon action at law therefore for ruinous damages was the chief entertainment of the parties concerned, and it was a dire struggle between the farm and the factory. The effect of all this was seriously considered by the late Earl of Derby, who brought it before the notice of Parliament and obtained the Act of 1863, which compelled the manufacturer of alkali to condense no less than 95 per cent. of all the muriatic acid derivable from the materials which were used; and last year the Act was amended so as to bring other manufactories, as copper works, where salt is the agent employed, as well as vitriol works, etc., under the Act. The amount of muriatic acid escaping from the alkali works is also restricted, not merely to 5 per cent. of the quantity made, but to one-fifth of a grain per cubic foot of the gas or air leaving the works. There is hope, therefore, that still further improvements will be effected in these operations.

The method of making salt-cake is first to treat common salt with sulphuric acid in pots (called saturating pots) at the head of a reverberatory furnace, and then to rake out the mixture upon the bed of the furnace, where it is subjected to a red heat for two or three hours. The muriatic acid, which is copiously evolved from the materials, is carried by pipes and flues to a high and capacious condensing tower, where it meets a stream of cold water flowing downwards over the coke with which the tower is packed. The draft of the tower is caused by the furnace shaft, into which the residuum of unabsorbed gas enters. In this way a liquid acid of 28 Twaddell (1·140 sp. gr.) is obtained, and this is used with oxide of manganese for making chlorine in the production of chloride of lime (bleach powder). The red-hot salt-cake, when drawn from the furnace into iron barrows, is highly charged with muriatic acid, which it gives off in copious fumes, so that the workmen are obliged to take some precaution to prevent its effects. The fumes, however, do not extend to any great distance—not many yards from the furnace—and they might be checked altogether by Dr. Roscoe's contrivance of raking the hot charge of salt-cake into a brick chamber underneath the furnace, and provided with an opening into the flue. All these arrangements are, however, under the immediate supervision of inspectors appointed by government, and they are generally managed with great precautions.

Not so careful, as a rule, are the manufacturers who extract *copper from spent pyrites by means of common salt*. The spent iron pyrites after having been used by the oil of vitriol maker in generating sulphurous acid contain from 2 to 4 per cent. of sulphur and a small proportion of copper. They are crushed to a coarse

powder and mixed with common salt (3 cwt. to a ton of pyrites), and then are roasted in a reverberatory furnace for several hours, whereby muriatic acid gas and a little sulphurous acid escape; and as the manufacturers have not hitherto been under any legislative obligations as regards the proportion of acid evolved, they have generally let it go freely into the chimney shaft. They will, however, be compelled to condense it by means of coke towers, as is done in alkali works.

Common bottle glass is now made from silica and common salt, which are fused together in huge melting pots, and thus immense quantities of muriatic acid gas are discharged into the air.

In like manner, the use of common salt as a means of *glazing the commoner kinds of pottery* (brown ware bottles, jugs, pans, pipes, etc.) is a cause of great offence at Lambeth and elsewhere, from the amount of muriatic acid discharged into the atmosphere.

Brick burning and cement burning are also sources of nuisance from the same cause. In the case of bricks, the salt comes from the cinders (household breeze) used in the burning, which become charged with salt in the dust bins of houses. In the case of cement burning, the salt is derived from the mud of the tidal rivers, from which, with chalk, the cement is made. In all these instances, when salt is heated with silica or clay, the alkali combines with the fixed acid and forms a fusible glass or glaze, while the volatile acid (muriatic) escapes. The remedy with the potter and cement manufacturer is to condense the fumes in a proper scrubber; and with the brickmaker the remedy is to use coke breeze, or household breeze that has been well weathered and washed by the rain.

2. *Nuisances occasioned by the escape of sulphurous acid.* This is most marked in the manufacture of oil of vitriol, which is always produced from the vapors of burning sulphur. The sulphur employed is either crude native sulphur or pyrites (which contains from thirty-five to fifty per cent. sulphur), and the spent oxide from gas works (which is a mixture of from forty to sixty per cent. sulphur with hydrated oxide of iron and sawdust). The furnaces for burning these several forms of sulphur are very different in their construction, but when properly managed the combustion of the sulphur should be complete, or nearly so, and all the fumes should be carried, without escape, into the leaden chambers. These chambers are of great capacity, as from 30,000 to 100,000 cubic feet, and they not only receive the fumes of the burning sulphur (sulphurous acid), but they likewise receive nitrous fumes from a pot or small stove containing nitre at the back of the sulphur furnaces, as well as jets of steam, which are blown into the chambers from a boiler. The chemical reactions which take place in the chamber are not precisely understood, but the practical effect of them is that the sulphurous acid, or anhydride (SO_2) with nitrous fumes (N_2O_3) and steam or water (H_2O) form sulphuric acid (H_2SO_4) and nitric oxide (N_2O_2). The former is precipitated to the bottom of the chamber, where it is dissolved in the water present, and the latter (nitric oxide) escapes to take oxygen from the air of the chamber, and so again forms nitrous fumes for a similar reaction. The nitrous fumes, therefore, are merely the carriers of oxygen from the air to the sulphurous acid, and would, in the presence of oxygen alone, act indefinitely; but as the oxygen of the air in the chamber is associated with nearly four times its volume of nitrogen, it follows that as the former is abstracted the latter accumulates, and must be replaced by fresh atmospheric air. Hence the necessity for a current of air through the chambers, and this current of air carries with it notable proportions of sulphurous acid and nitric oxide, which, escaping into the atmosphere by the chimney shaft, are the cause of injury to vegetation and annoyance to the neighborhood. The extent of this escape of noxious gases may be determined in several ways: First, the relation between the quantity of materials used and the amount of oil of vitriol produced. Theoretically, 100 parts of sulphur should produce 306·25 parts of monohydrated sulphuric acid (H_2SO_4); but in practice it varies from 200 to 294 parts. The nitre also employed at the works ought not to exceed 2 parts by weight for every 100 parts of sulphur, but in reality it is rarely less than 4 parts, and it ranges from this to 12 parts or more. In those cases where spent oxide is used as a source of sulphurous acid, the quantity of nitre is rarely less than 7 per cent. Secondly, the amount of escape may be ascertained by examining the gases which pass from the chambers to the chimney shaft. There is always a means of doing this with considerable accuracy by abstracting the gases from the flues which connect the chambers with the general shaft. According to Dr. Roscoe, a cubic foot of these gases ought not to contain more than one grain of sulphur in any form; whereas, in badly-managed works, the quantity may reach to sixteen grains per cubic foot. The air of the chimney shaft, also, should not contain more than a quarter of a grain of sulphur per cubic foot, and of this a little more than half is derived from the coke or coal burnt in the furnaces. The remedies for this waste are twofold: 1st. The exercise of care in the conduct of the works—regulating the sulphur furnaces so that no fumes escape therefrom, and a proper supply of air is admitted into the chambers. In well-managed works it is customary to have glass pressure siphons communicating with the exterior of the various chambers, so as to watch and regulate the condition of them. The chambers also should be completely surrounded and enclosed with cases, having a gallery or passage way around, so that any and every escape may be at once detected. 2d. The effluent gases should be passed through scrubbers charged with absorbent liquids. Oil of vitriol, for example, flowing through the scrubber in a small graduated stream, will absorb the oxides of nitrogen, as suggested by Gay-Lussac; and water will take up any trace of sulphurous acid. Both of these liquids can be made to flow into the leaden chamber, and be thus utilized. At several oil of vitriol works which I have inspected, it is the practice to carry the gases, which may by accident escape from these absorbent agents, through a lime purifier, before they go to the tall chimney shaft; and in this way all chance of annoyance is prevented.

The sulphuric acid which collects at the bottom of the leaden chamber is continually drawn off at a specific gravity of 1·600. This is called "chamber acid," and as it is too weak for general purposes, it has to be concentrated by evaporation. This is done to a certain extent in leaden pans, where it reaches a gravity of about 1·720, making the "brown acid" of commerce; and the further concentration is effected in vessels of platinum or glass, where the acid obtains a gravity of from 1·845 to 1·854, which is the "oil of vitriol" of English commerce. All of these operations are offensive, from the escape of the acid, unless they are well conducted.

It is necessary, therefore, in the management of oil of vitriol works, to take care—

First, that the sulphur furnaces are burning properly,

and are not permitting any escape of sulphurous acid.

Second, that the leaden chambers and flues therefrom are constantly sound and air-tight.

Third, that the gases in the flues from the leaden chamber do not contain above one grain of sulphur per cubic foot.

Fourth, that these gases are passed through a water scrubber and an oil of vitriol scrubber in succession, before they go to the chimney shaft; and

Fifth, that the evaporation and concentration of the chamber acid, as well as the brown acid, be conducted without the escape of offensive gases.

Another source of annoyance from the escape of sulphurous acid, is where the *noble metals are refined* by boiling the alloys in oil of vitriol. This, however, is easily guarded against by conducting the operations in closed vessels and carrying the evolved gases through an alkaline solution, whereby valuable sulphites and hyposulphites may be obtained for commerce.

Lastly, there is often a considerable escape of this gas from the chambers where *bleaching operations* are carried on by means of burning sulphur, as, for example, in the bleaching of woollen goods, straw bonnets, hair, hops, nuts, spice, etc.; and in these cases the refuse gas should be carried through some absorbent liquid or solid (lime, for example) by means of a fan or draught to a chimney.

3. *There are certain manufacturing operations attended with the escape of nitrous fumes* which are exceedingly irritating and offensive. As I have stated, these fumes may escape from badly managed *vitriol works*. They are also caused when *oxalic acid* is produced from saccharine matters by the action of nitric acid. *Refiners* also discharge large quantities of the acid into the air when they treat the alloys of the noble metals with nitric acid. The *makers of tin and iron* liquors, of *nitro-benzole*, and of *picric acid*, are likewise producers of these irritating fumes when they act upon the several materials with strong nitric acid. The remedy for the nuisance is the carrying on of such operations in closed vessels, and the conveyance of the nitrous fumes through water or an alkaline liquid (milk of lime), by which the red fumes are entirely absorbed or arrested.

In the manufacture of *bleach powder* (chloride of lime), there is occasionally an escape of chlorine, but it is nearly always accidental, unless the works are managed with great carelessness. The chlorine is generally made from the liquid muriatic acid, which flows from the condensing towers at the alkali works. The acid has a gravity of from 25 to 28 Twaddell (1·125 to 1·140), and it is run into a still upon peroxide of manganese, and stirred and heated so as to promote chemical action. The chlorine which is thus evolved is passed into chambers containing layers of finely slaked lime, slightly damp, to the depth of from 3 to 6 inches. The residual liquor in the still, which is a solution of chloride of manganese and free acid, of the strength of from 26 to 30 Twaddell, is, in many cases, not allowed to run to waste and be a cause of annoyance, but is treated with lime and air to recover the oxide of manganese. The first step of the process is to neutralize the free acid of the liquor by means of chalk (carbonate of lime), which does not decompose or act upon the chloride of manganese. When the effervescence is over, and the liquor has become clear by subsidence, the supernatant solution of chloride of manganese and chloride of calcium is drawn off into another vessel, called an "oxidator," where it is subjected to the action of a proper proportion of cream or milk of lime, which decomposes the chloride of manganese and forms a precipitate of oxide of manganese. Air is now blown into the mixture until the protoxide of manganese is converted into peroxide, and when this is complete it is allowed to settle, and the solution of chloride of calcium is either utilized or is run away to waste. Chlorine is also made from gaseous muriatic acid by the oxidizing action of the air at a high temperature. In this case the muriatic acid gas from the salt-cake furnaces is carried with atmospheric air into chambers heated to a low red heat (about 1000° Fahr.), and here, and in another chamber called an "oxidator," the hydrogen of the muriatic acid is oxidized and the chlorine set free. The mixed gases and vapors of chlorine, muriatic acid, and steam, are passed through condensers to cool them, and the moist chlorine is finally dried in a sulphuric acid scrubber, and then conveyed to the lime chambers. This method of generating chlorine requires care and attention, as the high temperature of the decomposing apparatus is very like to lead to fissures and cracks in the apparatus, which will permit an escape of irritating gases.

The last of the acid nuisances to which I shall refer is that caused by the manufacture of *superphosphate of lime*. In the early days of this branch of industry, it was the practice to make superphosphate of lime by mixing chamber acid, a little diluted with water, with ground coprolites, bones, and animal refuse of all kinds, by means of a shovel and an open trough. The fumes of acrid gases and vapors which were thus freely evolved into the air were extremely offensive to the neighborhood. At present the mixture is effected in a closed vessel, in which a stirrer revolves horizontally. The best form of mixer is about ten feet long and four feet in diameter. The materials which are used in the manufacture are ground coprolites, crushed bones, spent animal charcoal from sugar refineries, and animal refuse of all kinds. These are put into the mixer in proper proportions, and treated with water and sulphuric acid. The mixer has an upper opening for the admission of the materials, and a lower one for the exit of them. Both of these openings are secured with air-tight valves; and during the mixing, which lasts from five to ten minutes, the materials evolve vapors charged with organic fumes and the acrid and exceedingly irritating tetra-fluoride of silicon, which is produced by the action of sulphuric acid upon the fluorides and silicates contained in the coprolites. These gases and vapors are conveyed from the mixer by a special shaft or flue, which carries them first to a chamber, in which they meet a copious spray of water, and then through a coke-scrubber or condenser, having a stream of water; and lastly, in some cases, through a lime purifier before they reach the furnace-shaft. When the materials are thoroughly incorporated in the mixer, they are discharged through the lower opening into the chamber or den, in which, in the course of twenty-four hours, they consolidate. This chamber should also be air-tight, and ventilated into the same shaft or flue which carries the gases from the mixer to the condenser. If these operations are properly managed, they may be conducted without other offence to the neighborhood than the faint acid smell which is inseparable from the exposure of the consolidated superphosphates: but if they are not well designed and managed, they are the cause of insufferable nuisance. The object of having a fine spray of water, as the first absorbent of the acid gases,

is that the tetra-fluoride of silicon is immediately decomposed when it comes into contact with water, forming hydrate of silica, which is deposited in a pulpy form, and an acid called hydrofluosilicic acid, which the water dissolves. Now, if this were to take place in a scrubber packed with coke and supplied with downward flowing water, this hydrate of silica would soon clog the pores and apertures of the scrubber, and throw it out of action. Hence the necessity for decomposing the tetra-fluoride of silicon in a chamber before it reaches the coke-scrubber.

And now, in concluding this brief outline of the processes which are most likely to receive attention from Medical Officers of Health, I may summarize the recommendations which I have ventured to submit as the best means of abating the nuisances referred to, by saying—

First, that all noxious and offensive operations should be carried on, as far as possible, in air-tight chambers, which can be ventilated by means of fans, or by the chimney draft.

Second, that all condensible and absorbable gases and vapors should be passed through condensers and absorbents best suited for their absorption—as water in spray, and scrubbers charged with water, oil of vitriol, or alkaline solutions.

Third, that when necessary, these scrubbers should be supplemented with special purifiers, as hydrated oxide of iron, hydrate of lime, etc.

Fourth, that organic vapors and sulphuretted hydrogen and empyreumatic matters should be conveyed to the furnace fire and destroyed. In carrying out this part of the process, it is necessary that all steam should be condensed from the vapors, by cooling them thoroughly before they reach the fire, as otherwise the fire is apt to be put out by them. The fire which is best suited for this purpose is that which is actually used in manufacturing operations, as special fires are very likely to be neglected; and the best place for the entrance of the noxious vapors is at the back of the ash-pit immediately under the fire bars, as by this means a draft is secured (by closing the ash-pit), and the vapors are made to pass through the glowing coals of the fire.

Fifth, all offensive materials should be brought to the works, or carried away from them, in properly constructed carts or tanks, which can be closely covered; and all such material when stored at the works should be kept in close tanks or chambers, ventilated, when necessary, by the scrubbers or furnace fire.

Lastly, the whole of the operations should always be managed with care and attention to details—there being no neglect of the sound condition of every part of the plant or working apparatus.

With these precautions, which are by no means unreasonable or impracticable, the manufacturer of offensive products might generally so conduct his operations as not only to protect the public from annoyance, but also to secure his own interests by preventing unnecessary waste.

It will be observed that I have not dealt with the question of nuisances from the slaughtering of cattle, etc., as this has already received attention from the society, through the labors of our colleague, Dr. Dudfield; in fact, our recommendations have been accepted by the Metropolitan Board of Works.

In conclusion, I trust that I may soon be able to find time for a further treatment of the subject by describing the nuisances which arise from the second and third causes alluded to at the beginning of the paper.—*Public Health.*

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS.

In the preparation of these abstracts the Editors are assisted by the following chemists:—

M. Alsberg, Ph.D.,
E. H. S. Bailey, Ph.B.,
Prof. G. F. Barker,
T. M. Blossom, E.M.,
H. C. Bolton, Ph.D.,
G. C. Caldwell, Ph.D.,
Miss Josephine Chevalier,
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C. A. Goessmann, Ph.D.,
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Louis H. Laudy,
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H. Newton, E.M.,
Prof. F. Prime, Jr.,
Ira Remsen, Ph.D.,
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P. Schweitzer, Ph.D.
W. Shapleigh,
T. O'C. Sloane, E.M.,
Prof. A. P. S. Stuart,
D. K. Tuttle, Ph.D.,
E. Waller, E.M.,
E. H Williams, A.B.

Annalen der Chemie.

Vol. 174, No. 1.

Conduct of **ozone towards water and nitrogen.**—L. Carius.—Ozone does not oxidize water to hydric peroxide, and at medium temperature it does not oxidize nitrogen in presence of water. Numerous determinations of the absorption of ozone by water, and the coefficient of absorption at $+1^{\circ} = 0{\cdot}834$ (76 mm.).

It is very soluble in water, but is slowly converted into ordinary oxygen in contact with it.

On the formation of **nitrous and nitric acids and hydric peroxide in nature.**—L. Carius.—Ozone takes no part in this formation from free nitrogen, and no compound of a nitro-acid and ammonia is produced by the evaporation of water. Ozone and ammonia react as follows:—

$(NH_3)_2 + (O_3)_4 = N(NH_4)O_2 + O_2H_2 + (O_2)_4$, and
$(NH_3)_2 + (O_3)_4 = N(NH_4)O_3 + OH_2 + (O_2)_4$.

These acids are formed in nature from free nitrogen—
1. By electric discharge in air.
2. By oxidation of other bodies in air.

From oxidation of ammonia—
1. By electric discharge.
2. By presence of so-called alkaline substances.
3. By ozone.

On **dimethylacetic acid.**—A. Wischnegradsky.—This acid was obtained from the nitrite from synthetic propionic acid by treatment with hydrochloric acid. Boils at 187°, is a colorless liquid insoluble in water, and solidifies at —14°.

Palladium oxide in hydrogen gas.—F. Wohler.—Black oxide of palladium is reduced by hydrogen with production of light. Good lecture experiment.

On the **oxidation of the oxyacids of the fatty series.**—N Ley and A. Popoff.—By the oxidation of pseudopropyl-oxyacetic acid are produced isobutyric acid and carbonic acid.

The oxidation of secondary oxyacids takes place according to this scheme:—

$$\begin{matrix} R—CHOH \\ | \\ COOH \end{matrix} \quad \text{furnishes } R—COOH \text{ and } CO_2 + H_2O.$$

On **peucedanin and oroselon.**—H. Hlasiwetz and H. Weidel.

To the knowledge of **glycerin ether.**—Victor von Zotta.—This ether was prepared by distilling glycerin and calcic chloride. Phenol was thus produced in considerable quantity also. The ether has the formula $C_6H_{10}O_3$, and the formation of phenol is explained thus:— $C_6H_{10}O_3 - 2H_2O = C_6H_6O$.

On the preparation of **iodine substitution products** after the method with iodine and mercury oxide.—P. Weselsky.—By this method only the aromatic compounds or those closely allied to them can be treated, and certain conditions of constitution must be fulfilled.

Ludwigite, a new mineral from the "Banate."—G. Tschermak.—This is a borate of magnesia with protoxide and sesquioxide of iron—

$$3MgO, B_2O_3 + FeO, Fe_2O_3.$$

On the conversion of **benzoldisulphuric acid into terephtalic acid.**—R. Fittig.—This confirms the statements of Irelan and Garrick to the effect that dicyanbenzole furnishes terephtalic acid, and contradicts Prof. Barth, who found it to yield isophtalic acid instead.

On the structure of **pinacoline.**—A. Butterow.—The structure may be either—

$$\begin{matrix} C(CH_3)_2OH \\ C(CH_3)_2OH \end{matrix} \quad \text{or} \quad \begin{matrix} C(CH_3)_3 \\ C(CH_3)(OH)_2 \end{matrix};$$

the author is inclined to the former. R. H.

Bulletin de la Société Chimique de Paris.

Vol. xxi., No. 9.

Preliminary notes upon **pimaric acid.**—A. Cailliot.—A discussion is presented upon the point of fusion, microscopic characters, the effects of different solvents, and the transformation of pimaric acid to dextropimaric and pyromaric acids. Other derivatives are to be described later.

On the action of **chloride of trichloracetyl upon amines** of the aromatic series. 1. Action of chloride of trichloracetyl upon phenylamine.—D. Tommasi and R. Meldola.—Chloride of trichloracetyl is acted upon by anilin, and phenyltrichloracetamide is formed in accordance with the following reaction:—

$$\begin{matrix} C_6H_5 \\ H \\ H \end{matrix}\Big\}N + \begin{matrix} C_2Cl_3O \\ Cl \end{matrix}\Big\} = \begin{matrix} C_6H_5 \\ H \\ C_2Cl_3O \end{matrix}\Big\}N + \begin{matrix} H \\ Cl \end{matrix}\Big\}$$

The crystals formed are in the form of yellowish-white rhomboidal plates, melting at 94°, and soluble in ether, sulphuric acid, bisulphide of carbon, etc. Concentrated nitric acid decomposes them, producing a liquid which solidifies with water, and which analysis shows to be dinitrophenyltrichloracetamide—

$$\begin{matrix} C_6H_3(NO_2)_2 \\ H \\ C_2Cl_3O \end{matrix}\Big\}N.$$

No. 11.

Resumé of a communication upon **cohesion.**—M. West.—The author calculates the effects of cohesion, makes known the cause, and states accurately the measure and the law governing the force. Finally he deduces from these elements the distance between the centres of molecules, and gives examples.

Note upon **manganic acid.**—T. L. Phipson.—In a recently published article M. P. has called attention to the fact, that probably permanganate of potassa should be bimanganate, analogous with bichromate. M. Terreil has more recently arrived at similar conclusions.

Thermal researches upon **hydrogen.**—P. A. Favre.—It is maintained that palladium in absorbing hydrogen forms a body of definite composition, dependent upon thermal effects of a different order from absorption of gas by solid bodies. In hydride of palladium, hydrogen is in an active state, as certain elements are in explosive compounds. Hydrogen must then have two allotropic states, like oxygen.

No. 12.

Compounds of **cerium.**—Severin Jolin.—A variety of salts are made and described.

On an apparatus for the continuous **preparation of chlorine in the cold.**—A. Mermet.—The apparatus consist of two bottles with tubulatures near the bottom connected by caoutchouc tubing. One bottle contains hydrochloric acid, one volume to three volumes of water, the other chloride of lime which has been previously moistened, rolled into small balls, which are dried in the air till they have absorbed some carbonic acid. These are supported upon pieces of broken glass. The gas is regularly disengaged, upon opening a stopcock inserted in the top of the chloride of lime bottle, and may be purified for use.

Means of **distinguishing New Zealand flax** from hemp, linen, etc.—E. Vitrebert.—The sample is placed in a solution of anilin blue or of fuchsine, containing about a decigramme of coloring matter per litre. After standing a few seconds at 80° or longer in the cold, upon washing the fibre, it is found that the flax is strongly colored, while the hemp, linen, etc., remain uncolored. This process has not been successfully applied to distinguish the fibres in paper.

On the preparation of **organo-metallic compounds** of the hydrocarbons of the series C_nH_{2n}.—D. Tommasi.—A brief discussion and some experiments on the existence of combinations of the diatomic radicals with the metals.

Action of **chloride of benzyl upon camphor.** Part II.—D. Tommasi.—In a previous article the author has announced, that by the action of chloride of benzyl upon camphor in the presence of zinc he has obtained a product, which by fractional distillation was made to yield six different substances. Each of these is redistilled and the product discussed. That boiling at 189° to 190° may be considered as an isomer of oxycymol or of carvol, having a formula $C_{10}H_{14}O$.

Vol. xxii. No. 1.

Action of **ammonia upon phenylchloracetamide** and cresylchloracetamide. — D. Tommasi. — Phenylchloracetamide is acted upon by a saturated solution of ammonia gas in weak alcohol. The products are separated by crystallization, and purified by washing. A compound called phenylhydroxylacetamide is formed, in accordance with the following reaction:—

$$\begin{matrix} C_6H_5H \\ CH_2Cl—CO \end{matrix}\Big\}N + \begin{matrix} NH_4 \\ H \end{matrix}\Big\}O = \begin{matrix} NH_4 \\ Cl \end{matrix}\Big\} + \begin{matrix} C_6H_5,H \\ CH_2OH—CO \end{matrix}\Big\}N.$$

An atom of chlorine is replaced by an atom of hydroxyl.

Cresylhydroxylacetamide is obtained in a similar way from cresylchloracetamide.

Action of **sulphide of carbon upon benzoin, balsams, and resins.** — P. Guichard. — Purification of various resins is considered, and a variety of interesting

facts deduced in reference to the action of this reagent upon them.

On the **iodide of ethylidene.**—G. Gustarvson.—Chloride of ethylidene is made to fall, drop by drop, into a solution of sulphide of carbon with iodide of aluminum cooled to 0°. After standing some time a liquid separates, which is decanted, distilled, freed from sulphide of carbon and water, and redistilled. Iodide of ethylidene thus obtained may, by distillation with an alcoholic solution of potash, be transformed into acetylene and iodide of vinyl. This latter substance may be produced also by treating iodide of ethylene in a similar manner.

Determination of a mixture of **sulphides, of hydrogen sulphides, and of hyposulphites.**—M. Schlagdenhauffen.—The method of Dupasquier is modified; a new volumetric method is proposed and discussed at length, formulæ being introduced to facilitate calculation.

Modification of the **blowpipe.**—A. Dupré.—Luca's blowpipe is modified as follows: In the place of the mouth-piece is soldered a cylindrical tube about 1 centimetre in diameter and 4 centimetres long, having several openings just above the point of juncture. The open end of the cylinder is closed by a cork through which passes the mouth-piece, to the lower end of which is attached a Bunsen valve (a caoutchouc tube with a longitudinal slit). A piece of very elastic rubber hose is attached by ligatures, one end to the cylinder just below the cork, the other to the conical part of the tube below. The expansion of this rubber takes the place of the expansion of the muscles of the cheek, and the valve prevents the backward flow of the air.

Facts observed in the study of **sugar.**—E. J. Maumene.—The new densities which are obtained by the author necessitate a valuable series of connected tables for sugar determination and an improved saccharometer.

Upon a process for the **determination of tannin in wine.**—E. J. Maumene.—A known volume of wine is measured off, to which is added some alcohol. Pour into this a solution of caustic baryta, in excess, also nitrate or chlorhydrate of ammonia. Heat for a few moments, allow to cool, wash precipitate with concentrated alcohol, then with cold water. Treat the tannic precipitate with boiling dilute sulphuric acid, and determine tannin in the solution by permanganate of potassa.

No. 2.

Action of **bromine upon uric acid.**—Contributions to the study of the iso-alloxanates and of murexide.—L. Magnier de la Source.—Parabanic acid was first made by the action of bromine in excess upon uric acid in the presence of water. Urea and alloxane are first formed, $C_5H_4N_2O_3 + Br_2 + 2H_2O = CON_2H_4 + C_4H_2N_2O_4 + 2HBr$, afterwards $C_4H_2N_2O_4 + Br_2 + H_2O = C_3O_3N_2H_2 + CO_2 + 2HBr$.

Uric acid held in suspension in water is gradually treated by bromine, the solution heated on a water-bath has hydrogen passed through it, and a reddish deposit appears, which is supposed to be the anhydrous alloxane studied by Hardy. The solution yields, by addition of baryta water, a precipitate which is shown to be baritic alloxanate ($C_4H_2BaN_2O_5 + 2H_2O$). By treating the original solution with ammonia instead of baryta water, and adding alcohol, a reddish precipitate is obtained which is shown to be iso-alloxanate of ammonium ($C_4H_2(NH_4)_2N_2O_5$).

Mineralogical Notes.—A. Guyard.

I. On the **coloring matter in crude nitre.**—The substance that imparts the yellow color is chromate of potassa; that giving the violet is nitrate of manganese. The rocky material accompanying the nitre is found also to contain variable proportions of chromate of lime and of magnesia.

II. On the existence of **periodate of soda in nature.**—Iodine usually exists in nature in the form of iodate of potassa, rarely as periodate of soda. When the ordinary test will not reveal the presence of iodine, existing in nitre, it is present as periodate of soda. If iodine exists in the state of iodate, it is almost always in the state of iodate of potassa; but when as periodate, always as periodate of soda.

III. On **sulphuricine.**—A siliceous mineral from Greece has the following composition:—

Sulphuric acid, free	6·80
Sulphur	4·10
Water	6·10
Silica	80·38
Lime	1·25
Alumina	·43
Oxide of iron	·57
Magnesia	·37
	100·00

IV. On a **very curious mineral,** locality unknown.—Its composition is, iron and chromium 65%; arseniosulphide of nickel, 35%.

On the composition of **hippomane.**—M. Yvon.—A product of variable form found in connection with the allantoid membrane of the mare. It has the appearance of gluten, and from analysis is of the following composition:—

Water		76·19
Organic matter		9·21
Fatty matter		1·64
Lime (Oxalate and Carbonate)		3·59
Ammonio-Magnesian Phosphate	$2MgO$ 1·425 PO_5 2·530 NH_4O 0·926 12Aq 3·844	8·73
Undetermined and loss		·64
		100·00

Analysis of an **intestinal calculus of a sturgeon.**—B. Delachanal and A. Mermet.—

Water	11·75
Organic matter containing 0·8 of nitrogen	15·65
Phosphoric acid	40·44
Sulphuric acid	·94
Lime	31·45
Magnesia	·50
Alumina and oxide of iron	·14
Lithia	.08
Potassa and soda	traces

E. H. S. B.

Frescnius' Zeitschrift für Analytische Chemie.

1 Heft, 1874.

Organic analysis by reduction.—Henri Cretier.—This method depends on the reduction of the volatile products in the combustion tube by magnesium. A known weight of that metal being taken, the portion remaining after combustion is determined by dissolving in dilute sulphuric acid and measuring the hydrogen. The gaseous products of the combustion are determined according to the usual methods of gas analysis. The

analyses given are not as accurate as could be desired, but it is possible that with some improvements the method may yet be made to yield good results.

On the remarkable deportment of **chlorides, bromides, and iodides, with reference to the guaiac copper reaction.**—Edward Schaer.—From this it appears that the above classes of salts all give the same blue color which has been given as a test for the presence of cyanides, ferro-cyanides, sulpho-cyanides, etc.

Technical chemical gas analysis.—Dr. Clemens Winkler.—The accompanying drawings being necessary to a proper understanding of this paper, we must refer the reader to the original. The same is also true of the following five articles:—

Apparatus for gas analysis.—J. S. Buchanan.

Apparatus for the preparation of mixtures, with exclusion of the atmosphere.—Dr. Richard Gscheidlen.

A new gas lamp.—Stöckman.

An alcohol lamp by means of which a white heat may be obtained.—H. Dornbusch.

A sediment separator.—A. Gawalovski.

A rapid method of analysis of the various sorts of **sugar of lead.**—R. Fresenius.

On the determination of **sulphur in pig-iron, steel, etc.**—R. Fresenius.—Recommending the entire exclusion of the atmosphere from the apparatus used for this purpose, hydrogen being passed through before the act of solution is begun, and also after its completion. J. Moffatt Johnson substitutes, with good results for the lead solution, a solution of bromine in hydrochloric acid.

2 Heft.

Catechuic and catechu-tannic acids.—Julius Löwe.—A continuation of the author's previous researches on this subject. The formulæ of the two he has established as follows:—

Catechuic acid, $C_{15}—H_{14}O_7$.
Catechu-tannic acid, $C_{15}—H_{12}O_6$.

On the **double sulphate of iron and soda.**—E. Biltz.—A reply to F. Mohr on this subject. The author finds the salt in question easily prepared in a pure condition, and very stable, and recommends it for use in preparation of a normal solution for volumetric determinations.

A simplification of Bunsen's method for the **determination of urea.**—G. Bunge.

Analytical Notices.—Dr. A. Hilger.

1. The detection of **selenious and tellurous acids.**—Both of these acids and their alkaline salts give, with magnesic chloride or sulphate in presence of ammonic chloride, precipitates similar to the ammonio-phosphate of magnesia.

2. On the detection of **calcium, magnesium, barium, strontium, and iron, in presence of phosphoric or oxalic acids.**

On the solubility of **plumbic sulphate in solutions of sodic acetate.**—Dr. H. C. Dibbitts.

A felt filter.—Dr. R. Frühling and Dr. Julius Schulz.

A cylinder for use in **areometric determinations,** by means of which the normal temperature can readily be obtained.—A. Gawalovski.

Analytical Notices.

On the conversion of the **alkaline sulphates to the chlorides** by ignition with ammonic chloride.—Francis C. Phillips.—When the mixture is ignited at a low heat, the whole of the ammonic chloride is volatilized without change. If, however, a high heat is used, after several repetitions of the same operation, the alkaline salt is almost entirely converted to the chloride.

On the **analysis of acetate of lime.**—R. Fresenius.

3 Heft.

On the analysis of commercial **anthracene.**—Dr. E. Luck.—For the details here given we must refer the reader to the original paper.

On a molecular compound of **hyponitric oxide with phosphate of magnesia.**—Dr. E. Luck.—When pyrophosphate of magnesia is dissolved in nitric acid, evaporated to dryness, and ignited over a small flame, the mass at first assumes a brown color, which only gives place to the pure white of the pyrophosphate at a low red heat. The composition of this brown substance is expressed, according to the author, by the formula—

$$2(HMgPO_4) + NO_2.$$

Examination of nitro-glycerin.—Filipp Hess.—Results of a number of nitrogen determinations, according to the various methods of Dumas, Siewert, and Schulze. These seem to show that nitro-glycerin never consists of the tri-nitro compound alone, the amount of nitrogen being always 2–4.5% less than is required for the formula of that compound.

Sugar determination in beets.—Dr. A. Heintz.

Apparatus for **rapid determination of moisture** in hygroscopic organic determinations.—A. Gawalovski.

An apparatus by means of which **organic liquids can be treated with gases without foaming.**—R. Gscheidlen, and M. Traube.

Contributions to the knowledge of **cadmium,** with special reference to its quantitative determination.—O. Follenius.—The first paper on a thorough review of the comparative merits of the various methods of determination.

C. A. S.

Les Comptes Rendus de l'Académie des Sciences.

Vol. 79, No. 11.

On some **tungsten minerals** of Meymac (Coneze).—Ad. Carnot.—These consist of tungsten, Shéelite, and hydrated tungstic acid.

Tungsten.—This occurs in laminated masses with easy cleavage. Is not so black or brilliant as some other varieties. Is not magnetic. Specific gravity 6·54. Undergoes slight loss of weight by action of heat.

Analyses.	I.	II.	III.
Tungstic acid	74·75	74·25	72·67
Ferrous oxide	16·17	15·85	14·70
Manganous oxide	6·40	6·51	3·38
Lime	0·40	0·80	0·70
Magnesia	0·17	0·04	traces
Tantalic acid	0·95	1·10	0·90
Quartz, clay, etc.	1·12		4·00
Water		0·70	1·55
Total,	99·96	92·25	99·50

Schéelite.—Formula CaO,WO_3. Crystalline texture, vitreous or slightly adamantine lustre, gray or brownish color. Fracture laminated and often irisated.

Tungstic acid	74·50	74·20
Lime	18·70	18·84
Ferrous oxide	1·05	1·51
Manganous oxide	0·30	0·35
Tantalic acid		0·40
Gangue (quartz)	5·20	4·24
Total,	99·75	99·54

Hydrated Tungstic Acid.—Color, brown; texture, crystalline, with well-marked cleavage; lustre, resinous; contains water and some lime and oxide of iron. Heated, color changes to orange, and finally to black, and it gives off water. With microcosmic salt in the oxidizing flame it becomes pearl-yellow, almost colorless on cooling. In reducing flame it is violet or red from the presence of the oxides of iron and tungsten. Ammonia partially dissolves the substance in the state of powder. Heated with nitric acid it becomes yellowish-white; with hydrochloric, dirty-green. If zinc is added with the latter a characteristic blue color results from the reducing action.

Analyses of different specimens.	I.	II.	III.
Tungstic acid . . .	71·85	74·25	75·12
Tantalic acid . . .	1·00	1·05	0·70
Lime	2·50	4·65	7·00
Oxide of iron . . .	6·00	6·10	6·25
" " manganese . .	0·75	0·65	0·32
Water	12·93	11.75	6·85
Gangue (quartz, mica, clay) .	4·50	1·85	2·55
Total,	99·53	100·30	98·79

Traces of magnesia and potash were found, doubtless from the presence of some silicates attacked by the acids. The formula would seem to be $2WO_3,5HO$ or $WO_3,2HO$. This mineral thus differs both in its external characteristics and its composition from the anhydrous tungstic acid (tungstite).

New conditions for the **production of the electric current**; its influence on chemical reactions.—A. Boillot.—The author, in his researches on the nature of ozone, and the reactions produced by electricity, has so modified his apparatus, that, instead of having the current act on the gases in a narrow annular ring, between two tubes, it traverses a much larger space. Under these circumstances, full as much ozone was obtained both from oxygen and air. These experiments, which are to be continued, would seem to show that the effects of electric action can be spread out considerably without the chemical reactions determined by it being much diminished.

The causes which modify the **setting of plaster**; new cements of lime and plaster.—Ed. Landrin.—In a recent note the author described the so-called *alum-plasters* which *set* slowly and become very hard, and he now discusses, in their practical bearings, the causes that hasten or retard the *setting* of plaster. A microscopical examination gives three stages: 1. On contact with water the plaster takes a crystalline form. 2. The water dissolves a certain amount of the sulphate of lime. 3. A portion of the liquid evaporates by the heat disengaged, a crystal is formed, and this seems to determine the crystallization of the whole. At the end of a certain time after this the plaster acquires its maximum hardness. Its formula is then $(SO_3,CaO)2HO$, as determined by experiment. The best effect is obtained when the plaster contains about 20 per cent of water. In practice this number is often exceeded on account of rapidity of *setting*. In damp places, where the setting is necessarily slow, as little water as possible should be added.

Causes which retard the Setting.—This may be done by an excess of water, but as this is inconvenient it is better to use substances like gum, glycerin, gelatin, etc., which serve to separate the crystals. It is a singular fact that inert materials like sulphate of baryta, sand, oxide of iron, etc., only diminish the solidity of the mass without producing any useful effect. The use of sulphuric acid, or alum, cements, as recommended by the author, will be very useful in this connection.

Causes which hasten the Setting of Plaster.—Stucco workers often wish to hasten the *setting* of their plasters, and accomplish it by placing on the surface of the mortar, anhydrous salts like sodic chloride, sodic carbonate, cupric sulphate, etc., which absorb water. The *setting* of very dry plasters is determined by a mixture of ordinary plasters. One of the latter *setting* determines the crystallization of the whole.

Influence of Lime.—During the calcining of plaster a part of the carbonate of lime is changed into lime, and the author finds the effect of the latter to be very favorable in the *setting*. The lime absorbing water raises the temperature, and gives the plaster a greater hardness. Ordinary plasters, containing 10 per cent. of lime, give very good results, polish well, and resist the action of atmospheric agents. The author has made cements with 75 per cent. of lime, which are very hard, and of small specific gravity, rendering them well adapted to light constructions.

Action of heat on phenylxylene.—P. Barbier.—1. Besides $C_{28}H_{14}$, derived from the double molecule of toluene, on which the author has studied the action of heat (*Comptes Rendus*, lxxix. p. 121), there is a series of isomeric hydrocarbons, arising from the union of a molecule of benzene with one of xylene, $C_{16}H_{10}+C_{12}H_6-H_2=C_{28}H_{14}$. As there are several isomeric xylenes, each ought to furnish a corresponding compound $C_{28}H_{14}$. Of these that from the xylene of tar oil and benzene has been prepared, and the effect of heat on it studied.

2. The author has prepared a new hydrocarbon, *phenylxylene*, by the method of M. Zincke, adding powdered zinc to a mixture of tolylchlorhydric ether and benzene. The tolylchlorhydric ether was obtained by the action of chlorine on xylene vapor. It boiled at 192°–196°. Mixed with three times its weight of pure benzene, and heated in the presence of powdered zinc, it undergoes a violent reaction with disengagement of chlorhydric acid.

3. The product of the reaction submitted to a great number of fractional distillations gives a liquid boiling at 270° to 280°.

By analysis.	I.	II.	$C_{28}H_{14}$.
C	91·8	92·1	92·3
H	7·9	8·0	7·7
	99·7	100·1	100·0

Phenylxylene boils at 283° to 286° (corrected). Its specific gravity at 0° is 1·01. Has a sweet, slightly alliaceous odor, and a blue fluorescence like solutions of sulphate of quinine, but not so marked.

$$\underbrace{C_2H_2,C_{12}H_4,C_2H_4}_{\text{Xylene.}}+\underbrace{C_{12}H_6}_{\text{Benzene.}}=\underbrace{(C_2H_2,C_{12}H_4C_2H_2)(C_{12}H_6)}_{\text{Phenylxylene.}}+H_2$$

$$\underbrace{C_{12}H_4,C_2H_4}_{\text{Toluene.}}+\underbrace{C_{12}H_4,C_2H_4}_{\text{Toluene.}}=\underbrace{(C_{12}H_4C_2H_2)(C_{12}H_4C_2H_4)}_{\text{Benzyltoluene.}}+H_2$$

4. Heated to dull redness in a tube for three minutes phenylxylene undergoes a slow reaction without deposit of carbon, and solidifies to a yellowish-white mass. The pressure in the tubes is slight, the gas is principally hydrogen with a trace of hydrocarbon vapor. Like its isomer, benzyltoluene, phenylxylene gives anthracene, or a mixture of anthracene and phenanthrene, but the secondary products of the reaction are different. Instead of toluenes it gives a mixture of benzene and xylene, volatile at about 140°, and giving terephthalic acid on oxidation—

$$2C_{28}H_{14}=C_{28}H_{10}+C_{12}H_6+C_{16}H_{10}+H_2,$$

so that it would seem that anthracene may be produced

not only by depriving the double molecule of toluene of its hydrogen, but by the action of benzene on xylene.

On a case of the **decomposition of hydrate of chloral.**—M. Sauret.—The author shows that hydrate of chloral in an alkaline solution can be decomposed after several hours by permanganate of potash into carbonic oxide, carbonic acid, formic acid, and an alkaline chloride. It is not necessary that either the permanganate or alkaline solution should be concentrated. He then suggests that the physiological action of hydrate of chloral depends on this principle, it being exposed to oxidizing action in the blood, and moreover the serum of the blood is known to be alkaline. The carbonic oxide set free expels the oxygen, and must be itself expelled to allow a return to consciousness. This slow decomposition may account for the continuity of its action when used to produce sleep, which could not be explained by regarding it as transformed into chloroform.

The lowering of bodily temperature observed by Mr. Cl. Bernard in cases of poisoning by carbonic oxide also, is similar to the effect produced by the administration of chloral.

On the **development of red vapors during the boiling of syrup.**—E. J. Maumené.—This strange disengagement of vapors is supposed to have been due to the existence of nitrates in the beet root sugar under process of manufacture.

To solve the question whether this decomposition was caused by the sugar itself or by foreign materials (a question of great interest to the manufacturer) the author treated very pure candied sugar in dilute solution with nitrates.

The nitrates of potash, soda, lime, and magnesia (proportion, 100 to 200 gr. water, do. sugar, 2 to 25 gr. nitrates) were tried with no effect, not the smallest amount of nitrous fumes being given off on prolonged boiling, even to dryness, and calcining till the mass turned black.

But the stability of these nitrates was thought to interfere with the success of the experiment, so nitrate of ammonia was tried, and on boiling, the liquid became dark colored at 120°, as if under the influence of acids. At 125° it was resolved into a mass of vapors with a cyanic odor, but containing NO_2 free, insoluble in water, and easily recognized. So the sugar may cause the formation of the red vapors, since the juice of the beet always contains some nitrate, and an ammoniacal salt. The remedy for this is very difficult. It would be necessary to expel the ammonia with lime, keeping the sap in lime-water for a certain time, as the author recommended some time previously. (Vide *Traité du Travail des Vins*, p. 236, by author.)

The **effect of gases in the coagulation of the blood.**—E. Matthieu and V. Urbain.—The authors give as the result of their experiments:—

1st. Spontaneous coagulation of the blood is due to carbonic acid.

2d. During life the obstacle to this coagulation is found in the blood globules, which take up not only the oxygen but the carbonic acid contained in the blood.

To return to (1) in proof of this, analysis shows that blood invariably contains less carbonic acid after coagulation than before. Further experiments and facts are brought forward to support this theory, and it is concluded that the reason that neutral salts, and also the alkalies as noticed by MM. Dumas and Prevost, prevent the coagulation of the blood, is because of their tendency to absorb carbonic acid.

Synthesis of purpurine.—F. de Lalande.—The author thinks that purpurine is not trioxanthraquinone, as has been generally supposed, and that the atom of oxygen, by which it differs from alizarine, not belonging to a hydroxyl group, could be introduced into the alizarine molecule by simple oxidation. He has obtained purpurine by subjecting alizarine, perfectly free, at starting, from purpurine, to the action of oxidizing agents. To 8 or 10 parts conc. sulphuric acid were added one part dried and pulverized alizarine, and one part dry arsenic acid or binoxide of manganese. The temperature was raised to 150 or 160°, till a drop gave the red color of purpurine in water containing caustic soda. A large amount of water is added, the precipitate then dissolved in alum and precipitated by an acid.

Analysis.	Matter.	Carbonic Acid.	Water.
	Gr.	Gr.	Gr.
I.	0·157	0·3765	0·051
II.	0·2085	0·500	0·0615

Which corresponds to—

	I.	II.	$C_{14}H_8O_5$ (calculated)
Carbon	65·40	65·40	65·62
Hydrogen	3·60	3·28	3·13
Oxygen			31·25
			100·00

The properties of the body leave no doubt that it is really purpurine. The author hopes to be able to transform alizarine directly into purpurine. J. M. M.

Archiv der Pharmacie.

April, 1874.

Detection of **foreign bitter materials in beer.**—Prof. Dragendorff.—This paper is divided into four sections. In the first the manner of preparing the beer for examination, and two methods of testing it are described; in the second the behavior of the normal constituents of beer by the use of the two methods is considered; in the third, by the same treatment, the behavior of foreign bitter, and often poisonous, principles used to adulterate beer is given; and in the fourth the author gives a *resumé* and table by which beer can readily be tested.

Method I. From 600 to 1000 c.c. of beer are evaporated to the consistence of syrup, then treated with three or four times its volume of alcohol free from fusel oil, and allowed to stand twenty-four hours in the cold. It is then filtered, the alcohol distilled, and the residual liquid, after standing twelve to twenty hours, is again filtered. The filtrate is now mixed with a few drops of dilute H_2SO_4 and then vigorously shaken with petroleum-ether. The petroleum-ether is then drawn off, washed with water, then drawn off from that, and finally, to remove the last traces of water, is filtered through a dry filter, and placed on watch-glasses to evaporate. The smell of the residue will often indicate the substance with which the beer has been adulterated. After the petroleum-ether has removed from the liquid all it can, the latter is subjected to similar successive treatment with benzine and chloroform.

Method II. The same quantity of beer as before is heated a short time to expel CO_2, then cooled and treated with basic acetate of lead as long as a precipitate is produced. Several of the normal constituents of beer are thus precipitated, while picrotoxin and some other adulterants remain in solution. After standing a short time the liquid is filtered, and the filtrate, in order to remove the excess of lead, is treated with dilute H_2SO_4, and again filtered. Long washing is avoided in both filtrations to prevent resolution of certain substances. If the filtrate from the lead sulphate before concentration tastes bitter or sharp, the beer has probably been adulterated. Add now to the filtrate ammonia to neutralize the free H_2SO_4, and concentrate the liquid to 180

or 200 c.c., and then treat it successively with petroleum-ether, benzine, and chloroform, as in Method I.

By the above methods the extracts of malt and hops were examined, first separately, then together, both before and after fermentation, and the properties of the soluble constituents, particularly of the bitter principles thus obtained, accurately ascertained by the proper reagents. Then the same extracts, with the addition in succession of various foreign bitter principles, like quassia, ledum palustre, absinthe, and menyanthes trifoliata were examined in like manner, and by the reactions peculiar to each, the means ascertained of detecting these adulterants.

The **chemical nature of dill oil.**—R. Neibzki.—This oil appears to be composed of at least two hydrocarbons and an oxyhydrocarbon, the latter boiling from 225° to 230°, and having for its formula $C_{10}H_{14}O$, and identical with carvol. Of the hydrocarbons, one boils from 170° to 175°, has the formula $C_{10}H_{16}$, and by its smell reminds one of the oil of mace; the other boils from 155° to 160°, resembles turpentine in smell, seems to have also the formula $C_{10}H_{16}$, and to be thus an isomer of the former.

The use of **alkaline silver solutions for detecting organic matter** in general, and the Finkelnburg reagent for the coloring matter of gall and urea in particular.—Dr. H. Vohl.—The author finds the statements of Finkelnburg concerning the use of alkaline silver solutions in detecting organic matters in solution inaccurate in every particular. Such solutions, therefore, are, in his opinion, of little use in a sanitary point of view.

Chemical examination of water used by the city of Sprattau.—C. Schneider.—The impurities found, particularly HNO_3, are supposed (whether correctly or not) to have induced the cholera in that city and vicinity in 1873.

May.

Detection of **bitter adulterants of beer.**—Conclusion.—Prof. Dragendorf.—Reactions are given for detecting cnicin, salicin, aloetin, picric acid, colocynthin, picrotoxin, colchicin, daphnin, capsicin, atropin, hyoscyamin, strychnin, brucin, and the bitter principles of erythræa centaurium, gentian, and juniper berries. The writer divides the adulterants into four groups: First, those that give nearly the same results by both methods; second, those that are better detected by the first than by the second method; third, those which are more readily detected by the second than by the first method; fourth, such as are not detected with certainty by either method.

To the first group belong absynthin, salicin, aloetin, capsicin, hyoscyamin, atropin, strychnin, and brucin. In the second are placed cnicin, colocynthin, daphnin, and the bitter principle of erythræa centaurium. In the third are found quassia, ericolin, menyanthin, picrotoxin, and colchicin. To the fourth belong gentian and picric acid

A table is added by means of which the examination of a beer can readily be made.

Case of **poisoning with barium carbonate.**—E. Berchardt.—Suicide was effected by a person 28 years of age. Symptoms were vomiting and diarrhœa, with fever and chills followed by death in about 36 hours. Post-mortem examination discovered an inflamed stomach and a white powder, at first mistaken for arsenic, but which proved to be barium carbonate. A small quantity of it was also found in the liver.

The **ethereal oil of the roots of spiræa ulmaria.**—Dr. R. Nietzki.—This oil obtained by distillation is supposed to be a compound of salicylic acid and methyl ether, and identical with that found in gaultheria procumbens, in the bark of betulalenta, and in the flowers of monotropa hypopitys.

The tartrates and citrates of iron, and their ammonium double salts.—C. Mehu.—A good way to prepare tartrate of protoxide of iron, perfectly white and unchangeable in the air, is to bring together equal weights of iron wire, tartaric acid, and water in a flask. The white granular powder should be washed until the last traces of acid are removed, to prevent oxidation of the iron on exposure to the air. Alcohol may be used for this purpose, but is not necessary.

The double tartrate of sesquioxide of iron and ammonium may be easily prepared by acting with NH_3 on moist tartrate of protoxide of iron with free access of air. Oxygen is gradually absorbed, and the double tartrate, when evaporated on plates, forms beautiful garnet red pellicles, not deliquiescent, but very soluble in water.

In a similar way the citrate of protoxide of iron, and the double citrate of the sesquioxide of iron and ammonium, can be better prepared than by the old method.

The **change from brown to green of the "neottia nidus avis."**—Von Prillieux.—The above plant has a brownish-yellow color, and no apparent tint of green. It seems, therefore, to be destitute of chlorophyl, but when put into alcohol, or other solvent of chlorophyl, it turns green, from which Prillieux infers not the existence of chlorophyl in the plant, but the change of a protein substance of the plant into chlorophyl by the action of the solvent.

Absence of morphine in the petals of the papaver rhœas.—Prof. Attfield.—The writer failed by three different methods to detect a trace of morphine in the petals of the red poppy, although a pound of them was used in each case.

Testing phosphoric acid with sulphuretted hydrogen.—Von Sarrazin.—When a solution of H_3PO_4 is saturated with H_2S, it often becomes turbid by standing a day or longer. The turbidity is supposed by some to be a sure indication of arsenic, but experiments of the writer show it may be owing simply to sulphur.

Glasswool.—E. Reichardt.—Glass drawn out as fine as the finest wool or silk, may be used with advantage for filtering in certain cases. That exhibited at the Vienna Exposition was manufactured in Bohemia; but it is now manufactured in Thuringen of excellent quality and for about $1·75 per ounce.

Material for polishing brass.—E. Reichardt.—A kind of linen of loose texture impregnated with water glass, when moistened with water serves very well for cleaning brass. The silica and alkali are supposed to be the chief agents in the work.

Carbolic acid and its relations to creasote.—A. M. Read.—One of the most common impurities of carbolic acid is coal tar oil. It can be detected by treating the acid with about twenty times its weight of water, when the oil will collect at the surface. To distinguish creasote from carbolic acid, Read gives the following:—

	With creasote.	With carbolic acid.
3 or 4 vols. of a saturated solution of barium oxide give	An imperfectly turbid solution.	A clear solution.
An alcoholic solution of sesquichloride of iron gives	A green color.	A brown color.
An aqueous solution of sesquichloride of iron gives	No reaction.	A blue color.
In glycerine	Creasote is soluble, but separable on addition of water.	Carbolic acid is soluble, but not separable on addition of water.

Watts and other authorities say carbolic acid is insoluble in NH_3. Read thinks it is soluble, but is not certain that its solubility is not owing to impurities.

Mercuric ethylchloride.—J. M. Maisch.—This salt is used like corrosive sublimate, and has the advantage over it of not precipitating the albumen of eggs, serum, or urine. A. P. S. S.

Polytechnisches Notizblatt.

No. 23, 1874.

To impart hardness and strength to sandstone by impregnation with silicate of alumina.—M. Lewin.—The sandstone is first saturated with a solution of sulphate of alumina and then with soluble glass. Insoluble silicate of alumina is precipitated in the pores of the stone.

Paste for photographers' use.—J. G. Tunny.—42 grammes of fine Bermuda arrow-root are well mixed with 25 grammes cold water; 330 grammes of water added and 4 grammes gelatine in fine shreds. It is then boiled about five minutes, until clear. When cold 25 grammes of alcohol and 5 to 6 drops of carbolic acid are added.

Preparation of **colorless, crystallized phenol.**—Dr. H. Schnitzler.—Carbolate of soda is distilled until the distillate begins to look milky. The residue is dissolved in water, allowed to settle, the soda neutralized with sulphuric acid, and then distilled in glass.

On **molecular changes in wrought iron.**—Prof. F. Kick.—If fibrous iron is intensely heated and suddenly cooled, a thin layer on the outside becomes crystalline. In the case of thin plates of boiler iron this may greatly diminish their original strength.

Bleaching bones and ivory with oil of turpentine.—Cloëz.—Bones exposed three or four days to sunlight in oil of turpentine are bleached perfectly. They should rest on little blocks to keep them out of the acid products which settle on the bottom.

Ozone and cholera.—Pettenkofer.—A discussion of the improbable connection between a want of ozone in the air and prevalence of cholera.

Testing for grape sugar in solutions of cane sugar.—Braun recommends the use of caustic soda and picric acid at a boiling heat.

Preservation of eggs in water glass.—This substance closes the pores of the cells and excludes the air.

No. 24.

Cast-iron pipes with cement lining.—Such pipe is strongly recommended for use in mines where the water contains acid. The pipes must be cleaned from rust, and the cement mixed to a thin paste without sand and poured in.

Caution against Marquart's vegetable hair balsam.—Prof. Dr. G. C. Wittstein.—In 100 parts there are 1·56 sugar of lead, 2·01 sulphur, 20·50 glycerin, and 75·93 spirits of lavender.

On the **ozone water swindle.**—The last specimen tested was from Kroll & Gærtner's factory, and contained no ozone, but traces of hypochlorous acid.

An **improved starch.**—Fine white starch is mixed with cold water, boiling water added, then white wax or stearine. To make it stiffer add gum Arabic in a powder. Squeeze through muslin.

Green bronze for iron.—Paul Weiskopf.—A solution of sylvinate of silver in oil of lavender is employed. E. J. H.

La Sucrerie Indigene.

Vol. ix., No. 10.

On the **accumulation of gelatinous substances in the continuous presses.**—E. Felz.—An account is given of the action of juice from a lot of coarse beets of luxuriant growth as to tops in the presses. In less than half an hour the presses which had been before working well with scarcely any gummy "frogspawn" were completely clogged with the gum which formed. On using other beets this clogging was removed, but recurred whenever the juice from that lot of beets was used. The view of Dr. Scheibler that this gum is a half-formed sugar is believed to be correct.

Note on the same subject.—P. Jubert.—Other facts are given tending to show that the "frogspawn" above mentioned is a ferment. Hot water, 90° to 100°, prevents their developing from the small portions inevitably left in the presses. The gum in forming develops carbonic acid, as any other ferment does. Their growth is proportional to their size. They do not readily develop in solutions containing but two or three per cent. of sugar.

Observations on the probable **influence of glucose on the crystallization of sugar.**—E. Davin.—From analysis of molasses out of which all the sugar which could be crystallized had been removed, it is concluded that glucose does not prevent the crystallization of sugar from its solutions. E. W.

Verhandlungen der k. k. Geologischen Reichsanstalt.

No. 5, 1874.

Analysis of an augitic-hornblendic-andesite from Toplitia near György, St. Miklos in Transylvania.—K. John.—This rock, which exhibited crystals of augite and hornblende under the microscope, gave the following result when analyzed. SiO_2 61·09; Al_2O_3 20·31; Fe_2O_3 5·10; CaO 6·09; MgO 0·81; K_2O 2·01; Na_2O 3·87; loss on heating 0·97; total 100·23. Sp. gr. of rock 2·6545.

No. 6.

Resin from the lignite of Dux, Bohemia.—This resin contains C 78·25; H 8·14; S 0.42; O 13·19. It closely resembles in its properties the retinite from Walchow (Walchonite). F. P.

Jahrbuch der k. k. Geologischen Reichsanstalt.

No. 4, 1873.

Mineralogical observations in the Argentine Republic.—A. Stelzner.—This article is divided into "the minerals of the granitic quartz deposits in the Sierra of Cordoba; the granular limestones of the Argentine Republic and their accessory minerals; the enargite lodes of the Famatina nitres; pseudomorphs of cerargyrite after native silver from Cerro Negro; Jamesonite from the Sierra of Famatina; Sinarite and its accompanying minerals from the Orbes mine in the Sierra de las Capillatis; Stromeyesite from the Hoyada; pseudomorphs after salt; and Clausthalite from Mendoza." The minerals occurring in the first of these are beryl, apatite, triplite, heterosite and columbite.

An analysis of the columbite gave the following result: CbO_5 77·73; WO_3 0·29; CuO 0·34; CaO 1·52; MgO 0·35; FeO 14·98; MnO 6·13; total 101·34. The analyses of the triplite gave the following results:—

	I.	II.
P_2O_5	35·65	31·13
FeO	18·30	15·88
Fe_2O_3	——	2·22
MnO	37·84	37·74
CaO	4·46	5·92
MgO	trace	trace
F	4·94	7·78
Gangue(SiO_2)	0·13	1·17
	101·32	101·84

The minerals found in the limestone are quartz, orthoclase, hornblende, magnesia-mica, tetanite, garnet, pistacite, coccalite, scapolite, wollastonite, chondrodite, serpentine, spinel, calcite, and malachite. Associated with the enargite is a new mineral which Stelzner calls famatinite. Although this occurs crystallized he has not yet been able to determine to what system it belongs, owing to a lack of material. It occurs massive and disseminated, sometimes having a granular or even rarely a lenticular appearance. Fracture uneven, slightly brittle. H=3·5, sp. gr. 4·39–4·59. Color a peculiar mixture of copper-red and gray; when exposed to the air for some time the color deepens, streak black. The calculated results from the analyses give S 29·71; Sb 22·65; As 3·50; Cu 44·14; total 100; corresponding to the formula—

$$4(3Cu_2S,Sb_2S_5)+(3Cu_2S,As_2S_5).$$

The blowpipe reactions are the following: it decrepitates in a closed glass tube; readily parting with a large quantity of sulphur, and, when highly heated, with antimony sulphide. In an open glass tube it evolves large quantities of white fumes, part of which are volatile, part non-volatile. On charcoal a black, brittle metal button is obtained with evolution of large quantities of fumes and coating of antimony. The other minerals associated with the enargite are chalcopyrite, covellite, pyrite, cupriferous melanterite, blende, gold, ruby silver, quartz, hornstone, barite, lithomarge, and sulphur.

No. 1, 1874.

Ludwigite, a new mineral from the Bannat.—G. Tschermark.—Ludwigite is purely fibrous, having a black to greenish-black color. H=5, sp. gr. 3·907–4·016. Streak greenish-black, but lighter than the color. The mineral is always associated with magnetite. Its analysis gave the following result: B_2O_3 15·06; F_2O_3 39·29; FeO 17·67; MgO 26·91; total 98·93. F. P.

Leobner Jahrbuch.

Vol. xxii., No. 2.

On the manner of conducting the **Eggertz assay** and of avoiding the green coloration in the steels containing but little carbon.—J. von. Ehrenwerth. — The green color is due to an excess of acid, and may be altogether prevented by a slight and gradual addition of acid.

Is there a tetra-carbide of iron?—R. Schoeffel.—The author comes to the conclusion that there is no such thing, and that the carbon unites with the iron in variable proportions.

Aphorisms from the **metallurgy of iron.**—P. Tunner.—The author calls attention to the physical and chemical changes undergone by iron. Iron wire, which is very brittle when first drawn, becomes very much less so if allowed to remain undistubed for a few days. Iron loses sulphur in the course of years. Gray pig-iron is produced with less fuel, in charcoal furnaces, when a siliceous charge is prepared than when a basic one is used, the SiO_2 acting as a substitute for C. In coke furnaces, on the contrary, where the greater part of the S is carried off in the slag as CaS, basic charges are to be preferred to siliceous ones, as the S is more powerful in producing white iron than the SiO_2 gray. When containing Si, steel is not rendered more brittle by the presence of Mn; on the contrary, its welding power and tensile strength are increased. Mn is a very active agent in separating S from iron. Mn promotes the absorption of C by iron, but as chemically combined C. In order to promote the reduction of Mn in a blast-furnace, this should work hot and with a basic charge to unite with free SiO_2. The amount of P which is fatal to the use of an iron, depended upon the manner in which the latter is manufactured and treated.

No. 4.

Patent process of working a blast-furnace with the use of gaseous fuels.—F. Reiser.—The inventor proposes using solid fuel merely to render the column of materials more porous, and to melt them just above the twyers, while the reduction and carburization of the ores is to be accomplished by introducing reducing gases and air at different points in the circumference of the furnace.

On **Bessemerizing with hot-blast.**—Heysonsky.—The attempt was successfully made at the Zeltwig Bessemer works, during the summer of 1874, to convert mottled iron with a blast heated to 700° C. Two practical difficulties caused a suspension of the experiment; one, the rapid destruction of the converter bottoms, the other that those parts of the converter in contact with the blast became so heated as only to be handled with great difficulty. F. P.

Zeitschrift für das Berg-, Huetten-, und Salinenwesen in dem Preussischen Staate.

Vol. xxii. Nos. 3 and 4.

The **Rachette blast-furnaces at Nischni-Tagilsk,** Ural Mts. — C. Frœhlich.—The results obtained there *seem* to have been satisfactory. [It must be borne in mind that they have proved unsatisfactory when tried in Germany both for iron and lead ores. F. P.]

Revue Universelle des Mines.

Vol. xxxv., No. 2.

On the **analysis of commercial sulphate of soda.**—J. J. de Koninck.—The only novelties in this article are the author's methods of treating the chloride and the water. The chloride is titered by argentic nitrate, using potassium chromate as indicator. As the solution is frequently too acid to permit the formation of argentic chromate, the author uses borax as neutralizing agent, which completely saturates the free acid, giving rise to boracic acid or a polyborate, which, like the borax, prevents the precipitation neither of the chloride nor that of the argentic chromate. The water is determined by heating the sulphate to perfect fusion, by which the water and free acid are expelled together with a little hydrochloric acid. The fused mass is afterwards titered, without the addition of borax (being neutral), to determine the loss of hydrochloric acid. This is subtracted from the total loss, as well as the sulphuric acid, when the water is obtained by difference.

No. 3.

Note on **phosphorus steels.** — A. Greiner. — The author describes the methods employed for steels of this class, manufactured at Zwickau (Saxony) and Schwandorf (Bavaria). The pig-irons used for this purpose, at the former locality, contain 0·10 to 0·12 p. c. P,

and 2·60–4·00 p. c. Mn; and at the latter a minimum of 0·10 p. c. P, and about 4 p. c. Mn. The steels made contain 0·185 p. c. P, and the Mn not determined. The only use to which these steels are put is as heads of rails, using fibrous iron for the web and base, granular iron, containing phosphorus, being placed between the steel and fibrous iron. F. P.

Berg- und Huettenmœnnische Zeitung, 1874.

No. 39.

The **Pozibram (Bohemia) lead and silver smelting works.**—G. J. Pilz.—Ores containing 50 p. c. Pb are roasted in sinter-roasting reverberatories until they contain but 2–3 p. c. S. They are then treated in round Pilz shaft-furnaces, having five and seven twyers, and an automatic siphon-tap; the fuel used being two-thirds charcoal and one-third coke—the latter of inferior quality. It is proposed to heat the blast. The lead obtained is cupelled in German cupelling-hearths with condensation chambers. These works may be considered a type of the most improved ones now in Germany. F. P.

RECENT CHEMICAL PATENTS.

January 12, 1875.

158,648.—Compounds for Unhairing Hides.—Henry Mower, Camden, N. J. The combination of lye from wood-ashes, or potash and lime which has been treated by the gas generated by sulphuric acid, sulphuret of iron, and water.

January 19th.

158,902.—Metal-coating Composition.—Eward J. H. Burrast, Parish of Lambeth, Eng. A composition consisting of chalk, kaolin, sulphate of iron, copper, refuse fat, and linseed oil or naphtha, for coating various metallic surfaces to prevent oxidation and corrosion.

158,924.—Apparatus for Concentrating and Evaporating Sulphuric Acid.—J. L. Kessler, Clermont-Ferrand, France.

158,979.—Appparatus for treating Cane-juice.—Francois Randon, New Orleans, La. A generator sends sulphuric acid gas into a receiver, which holds concentrated carbonate of soda and granulated coke. The coke distributes the sulphurous acid gas to the solution, thus liberating carbonic acid gas. Both are then passed to the bottom of bleaching column, which presents the juice over a series of inclined shelves.

February 2d.

159,355.—Apparatus for Generating Gas.—John H. Rawlings, San Francisco, and L. Irelan, Hatserville, Cal.

159,366.—Processes for Tanning Pickled Skins.—Wm. R. Space, Rochester, N. Y. The process herein described for tanning pickled skins by the use of liquid hydrocarbons or their alcohols, in conjunction with the hydrates of alumina.

159,440.—Apparatus for the Manufacture of Carbon or Lampblack.—Peter Neff, Gambier, and Levi S. Fales, Cincinnati, O.

159,446.—Manufacturing Milk of Magnesia.—Charles H. Phillips, New York, N. Y. Precipitates hydrate of magnesia from a solution of any soluble salt of the same by ammonia-water draws off the ammoniacal salt and washes the precipitate.

February 9th.

159,640.—Soap Compounds.—B B. Burke, Sullivan, Ind. The improved soap compounds of soda-ash, unslaked lime, bromide of potassium, muriate of ammonia, water, saltpetre, linseed-oil, and borax.

159,647.—Extracting Gold.—Frederick William Dahue, Swansea, Great Britain. Dissolves the gold in the form of chloride by treating the ore, regulus, etc., by hypochlorite of lime and hydrochloric acid, and precipitating the gold thus obtained from solution by sulphurous acid.

159,655.—Processes of treating Hydrocarbons for making Gas. Henry H. Edgerson, Fort Wayne, Ind.

6,278.—Carbonic-Acid-Gas Generators.—Otto Zwietusch, Milwaukee, Wis.

February 16th.

159,751.—Burning Hydrocarbons.—Oscar T. Earle, New York, N Y. The oil floats on water in a tank surrounded by a water-chamber, which will not feed water or generate steam. A superheating-coil rests on top of the apparatus.

159,801.—Refining Copper, etc.—S. L. Crocker, Taunton, Mass. Adds a small quantity of spelter in any form to copper ores, or partly-refined metallic copper containing antimony or arsenic, to remove the impurities during smelting.

159,816.—Gas-Retorts.—H. H. Goodwin, Camden, N. J.

159,881.—Fluxes for treating Ores.—P. U. Mackay, San Francisco, Cal.

159,837.—Manufacture of Grape-Sugar.—Edwin E. Pearse, New Handsworth.

159,887.—Treating Oils.—V. G. Bloede, Parkersburg, W. Va.

February 23d.

159,998.—Absorbing Ammonia Gas in Water.—John M. Beath, San Francisco, Cal. Mixes while in motion, and maintains uniformity of temperature and pressure while mixing.

160,018.—Process for removing Tin from Tin-scrap.—John Holliday and H. M. Baker, Brooklyn, N. Y. The tin-scrap is heated in a bath of fused alkaline nitrate, and then plunged into water.

160,053.—Manufacture of Gunpowder.—Edward Green, New York, N. Y.

160,191.—Fertilizing Compound.—Charles H. Hoffman, San Francisco, Cal. Compound composed of common liquid manure, salt, saltpetre, lime, stone oil, and sulphur balsam, in the proper proportions.

160,216.—Apparatus for Manufacturing Illuminating Gas from Liquid Hydrocarbon.—Hiram S. Maxim, Brooklyn, N. Y.

March 2d.

160,402.—Solutions for Chemical Telegraph-paper.—Thomas A. Edison, Newark, N. J. The solution prepared with ferridcyanide of potassium.

160,403.—The Solution prepared with Tannin and Hydrosulphuret of Ammonia.

160,404.—The Solution prepared with Tincture of Logwood.

160,440.—Manufacture of Leather.—H. Klemm and C. Klemm, Pfullingen, Wurtemburg, Germany. Ingredients: Sugar of grapes, train oil, tallow, and resin. Composition applied upon both sides of the hide, then "fulled" in a heated "fulling-tube" until the compound is absorbed.

6,313.—Coating Metals with Nickel.—Isaac Adams, Jr., New York, N. Y. To protect articles subject to heat and moisture against corrosion.

March 9th.

160,580.—Solutions for Chemical Telegraph-paper.—Thomas A. Edison, Newark, N. J. The solution prepared with aurichloride of sodium.

160,726.—Alkalies for Soap.—J. N. Stern, Keokuk, Iowa. A compound for making soap, consisting of caustic soda and common salt.

BOOKS RECEIVED.

Justus Freiherr von Liebig. Als Begrinder der Agrikultur-chemie. Eine Denkschrift, von August Vogel. München, 1874.

The Royal Bavarian Academy of Sciences, in just recognition of the large and varied part which Justus von Liebig performed in the wonderful progress that has been made in the science of chemistry in the course of the past few decades, invited several of his fellow-laborers and associates to commemorate the life and work of the eminent chemist who had for several years been the president of the society; and to August Vogel, a former pupil of Liebig in that first famous laboratory of his at Giessen, and an ardent student and investigator in agricultural chemistry, or subjects closely related thereto, was very properly confided the preparation of a memoir on Liebig's relations to agriculture.

In the beginning the author describes the low condition of agriculture previous to the time when Liebig came forward and so nobly and earnestly espoused its cause. Thaer, whom his grateful country has since recognized as the founder of scientific agriculture, did much to prepare the way for his greater follower, showing by his own example that agriculture was not, or at least need not be, a mere handicraft, and seeking to secure for this profession the honorable position which he believed that it deserved; but, though he had a few ardent admirers, he failed to make more than a beginning towards the accomplishment of this end.

Vogel reminds us that Liebig brought to the service of agriculture an uncommonly high and well-deserved reputation as an investigator, and an enthusiastic devotion to his chosen science; "he was every inch a chemist," he says of him.

Liebig's first work in this new field was a most searching study of the relation of the ash ingredients to the plant, and he first recognized the intimate connection between the ash of the plant and the mineral constituents of the soil.

He maintained that, the ash ingredients being not accidental and useless, but necessary and of vital importance, the addition of these mineral matters to the soil constituted a rational means of preserving its fruitfulness. In the prosecution of his studies in this direction a large number of analyses of ashes of plants was made in the Giessen laboratory and elsewhere by former pupils. The fact was established that the ashes of different orders of plants differ in a characteristic manner, while there are as marked points of resemblance between the ash of members of the same group. This truth Vogel regards as the foundation of "the mineral theory" in agriculture, with which Liebig's name is so generally associated.

Liebig's deep interest in real agricultural progress is next shown in the haste which he makes to carry into practice the results

obtained in the laboratory; the application of these results seemed to be, plainly enough, that the manuring of the soil need consist solely and alone in restoring to it the sum total of the ash ingredients carried off in the crops. But he found but little sympathy and co-operation among the class which he was so sincerely anxious to benefit, partly, says the author, because of the prevailing ignorance, and partly because the new ideas were so utterly at variance with the good old customs of the fathers and grandfathers of the farmers of Liebig's time.

A graphic account is given of Liebig's experiments with artificially prepared mineral fertilizers, in which with considerable trouble the alkalies were carefully converted into silicates, lest if supplied in a soluble form they would be washed out of the soil, and beyond the reach of the crop they were intended to feed, and of the unfortunate failure to obtain the expected good results.

While Liebig, still holding fast to the mineral theory, which he felt must be true, was in vain endeavoring to account for its entire failure when put into practice, Way's investigations on the absorptive power of soils for certain elements of plant food brought that long known, but little understood, property of soils into more prominent notice. Liebig soon saw the bearing of the results of others, and by himself, too, in this new direction, on the failure of his artificial fertilizers, and the mistake that he made, in converting his plant-food into insoluble forms, and thus confining it in minute particles, sparsely scattered through the soil. His own words are quoted, showing how painfully he felt his discomfiture, and how great was the burden removed when the explanation was found. "I was," said he, "when I understood why my manure did not act, like a man receiving a new life."

As the best exhibition of what Liebig did for agriculture, to give form and expression to it as a science, and to reform its practice, Vogel very appropriately quotes the fifty theories which are laid down as axioms in his earlier writings on agricultural chemistry.

The earnest efforts of Liebig to introduce and extend the use of commercial fertilizers in Germany are next mentioned. The intimate connection, between the rapidly increasing use of superphosphates and his own mineral theory, undoubtedly gave added zeal to these efforts. At the time that he broached that theory he predicted a brilliant future for the manufacture of commercial fertilizers.

Vogel mentions Liebig's endeavors in behalf of agricultural education. His first step in this direction was to induce the Bavarian government to furnish pecuniary assistance to a certain number of primary-school teachers from the rural districts, to enable them to attend his lectures on chemistry; through these teachers he hoped to instruct the farmers, and he regarded this as the most important result that he had thus far accomplished for the benefit of agriculture.

He strongly opposed the establishment of special schools of agriculture, but would have such schools connected with the universities, or with other parts of the educational system of the country, so that the students of agriculture should receive their instruction from the best teachers, working with the best facilities at their command. In accordance with this idea he succeeded in introducing instruction in agricultural branches of study in the polytechnic schools of the State, as well as in the university. He also secured the establishment of a central experiment station at Munich, which he looked upon not only as a means of making new and valuable researches in agricultural science, but also as an important auxiliary in the hands of the instructors in the school of agriculture in the University.

The memoir of which we have given this brief outline is an eloquent and worthy tribute, by a devoted friend and admirer of Liebig, to the really inestimable service which he has rendered in the course of agricultural progress. G. C. C.

The Bible on the Side of Science. By Howard Crosby, D.D., LL.D. Pamphlet, 8vo. 18 pp. New York, 1875.

Manual of Determinative Mineralogy, with an Introduction on Blowpipe Analysis. By George J. Brush. 8vo. 104 pp. J. Wiley & Son: New York, 1875.

Fifth Annual Report of the Secretary of the State of Michigan, relating to the Registry and Return of Births, Marriages, and Deaths for the Year 1871. 363 pp. Lansing, Mich., 1874.

Report of the Joint Standing Committees on Water, on the Waters of Flax Pond and Tributaries. Pamphlet, 8vo. 28 pp. Chelsea, Mass., 1875.

Results of an Examination of an Exploded Locomotive Boiler, and of Experiments to ascertain the Causes of Explosion. By Dr. Charles M. Cresson. Pamphlet, 8vo. 8 pp.

Annual Report of the Superintendent of the Onandaga Salt Springs. Pamphlet, 8vo. 39 pp. Albany, N. Y., 1875.

Geological Survey of Missouri.—Atlas accompanying Report on Iron Ores and Coal Fields. Raphael Pumpelly, Director. Pamphlet, folio. New York, 1873.

Atlas accompanying Reports of Missouri Geological Survey, 1874. By G. C. Broadhead, State Geologist. Pamphlet, quarto. Jefferson City, Mo., 1874.

Reports of the Geological Survey of the State of Missouri. 1855–1871. By G. C. Broadhead, F. B. Meek, and B. F. Shumard. 8vo. 323 pp. Jefferson City, Mo., 1873.

Report of the Geological Survey of the State of Missouri, including Field Work of 1873–1874, with 91 illustrations and an atlas. By Garland C. Broadhead. Pamphlet, 8vo. 734 pp. Jefferson City, Mo., 1874.

Geological Survey of Missouri.—Preliminary Report on the Iron Ore and Coal Fields, from the Field Work of 1872, with 190 illustrations in the text and atlas. By Raphael Pumpelly, Director. 8vo. 441 pp. New York, 1873.

Chemical Examination of Alcoholic Liquors.—A Manual of the Constituents of the Distilled Spirits and Fermented Liquors of Commerce, and their Qualitative and Quantitative Determination. By Albert B. Prescott, M.D., Professor of Organic and Applied Chemistry in the University of Michigan.

The Sewage Question.—The Water Carriage System, with an account of the lime and cement process of Major-General H. Y. D. Scott, C. B. 2 parts. 8vo. paper. London, 1874.

Manual de Chemie Pratique Analytique Toxicologique, Zoochimique, a l'usage des etudiants en medicine et en pharmacie. Par S. Ritter. 12mo. paper, illustrated. Paris, 1874.

Air as Fuel; or Petroleum and other Mineral Oils utilized by carburetting air and rendering it inflammable. By Owen C. D. Ross, M.I.C.E. 12mo. cloth. London, 1874.

Outlines of Proximate Organic Analysis for the Identification, Separation, and Quantitative Determintion of the more commonly occurring Organic Compounds. By Albert B. Prescott. 12mo. cloth. New York, 1875.

Adulterations of Liquors; with a description of the poisons used in their manufacture. By Oliver Cotter. 12mo. cloth. New York, 1874.

A Manual of Toxicology, including the consideration of the Nature, Properties, Effects, and means of Detection of Poison. By John J. Reese, M.D. 8vo. cloth. Philadelphia, 1874.

Cours de Technologie Chimique. Par Alf Salvetat. 4to. Text and plates. 1 vol., boards. Paris, 1874.

BREVITIES.

The Forging of the Platinum Ingot for the Formation of the International Measures.—M. Tresca has presented to the Academy of Sciences a very curious note in which is described, on the subject of this operation, a fact in thermodynamics truly worthy of interest. During the hammering of the ingot of platiniridium designed for the formation of the standard metre, the honorable subdirector of the Conservatory of Arts and Metres remarked that during the blow brilliant bands and luminous trains appeared when the metal, in its period of cooling, was still at a dull-red heat.

We do not insist on the theoretical consideration of this phenomenon, and will content ourselves with remarking that, perhaps, it may be regarded as a good example of the transformation of mechanical work into heat and light. M. Tresca observes with reason that the exceptional hardness of platiniridium cooled to a dull-red heat, requires, in being forged, a considerable amount of work, at least equal to that of the forging of steel. The ingot of platinum was finally brought to the form of a bar of square section and 4·5 metres long. In the new operations of forging which will take place, it is probable that the preceding phenomena will be reproduced. M. Tresca proposes to make it a special study in the experiments which he will carry on with his son M. Gustave Tresca, whose intellectual activity has already contributed to the success of the operations to which the ingot of platinum has been subjected up to the present date.—*La Nature.*

Dr. Leonhard Elsner, editor of *Chemisch-technische Mittheilungen*, died at Potsdam, Germany, November 29, in his seventy-third year.

The First Zinc Furnace erected in Silesia was at Wessola in 1798, by Johann Christian Ruberg. Gas furnaces were introduced there by Menzel (without success) in 1849. Henry Siemens introduced his regenerative furnaces in 1868.

Effervescent Baths are now recommended by some French physicians. A certain amount of acid carbonate of sodium is dissolved in the water, and sufficient hydrochloric acid nearly to neutralize the sodium salt is added. Salts of iron and other salts may also be added if required.

Evaporation of Water in Gas Meters.—Dr. Redner calculates that for every cubic metre of gas recorded as having passed through a wet gas meter twenty-three litres of aqueous vapor, or 2·3 per cent., by volume of the gas so recorded is aqueous vapor taken up by the passage of the gas through the water.—*Zeitschrift des Vereins Deutscher Ingenieurs.*

The Sun's Rays in Water.—A curious experiment has recently been made to ascertain how far the sun can penetrate the water.

The research was conducted upon the lake of Geneva, whose waters are among the clearest of the Swiss lakes, and the results have recently been communicated to the Society of Natural Sciences in the canton of Vaud, by M. Forel. He found that the chemical action of the sun's rays was felt in the summer time at the depth of between forty and fifty metres. We are not aware of the nature of the sensitive compound employed in these experiments, but hope shortly to learn more of the details.—*Photographic News.*

Lyceum of Natural History in the city of New York, Chemical Section, February 8, 1875. The following papers were read: Dr. H. Endemann, Notes on Zirconium. Prof. D. S. Martin, Suggestions on some points in Chemical Physics.

THE AMERICAN CHEMIST.

Vol. V. No. 11.

LIQUID CARBONIC ACID AS AN AGENT FOR EXTINGUISHING FIRES.

BY LIEUT. F. M. BARBER, U. S. NAVY.

In view of the inefficiency of the methods at present in use for extinguishing fires on board ship, and particularly sailing vessels, I would suggest the following plan, which I am of opinion can be made practically successful in all cases, including those of spontaneous combustion in cargoes of coal, cotton, etc. etc., of which there have been a number of instances recorded within the past year.

My proposition is to make use of the well-known extinguishing properties of carbonic acid gas; but in a manner which I believe has not hitherto been proposed. The plan is to have, in some convenient locality on the spar deck, or in any other suitable place, a flask or flasks about three feet in length and one foot in diameter, containing about one hundred pounds of the gas in a *liquid* condition. From the top or upper side of the flask a small iron pipe is to be permanently fitted along the water ways (or just under the deck), throughout the entire length of the ship. From this main pipe, at suitable intervals, are branch-pipes at right angles to the main, passing down next the skin to every store room and hold of the ship; so that each compartment of the vessel shall have its own pipe or pipes, reaching from its bottom to the main pipe at the spar deck. There is to be a cock in the main pipe near the gas flask, and one in each branch-pipe near the main, any one of which can be turned from the spar deck.

On the alarm of fire the hatches are to be battened down; the cock in the branch-pipe leading to the compartment where the fire is discovered is to be opened, and also the cock in the main next the gas flask. The liquid gas, which is under a heavy pressure in the flask, passes out through the pipe in the form of vapor as soon as the pressure is relieved by turning the main cock, and is driven in an instant by the great pressure behind it to the compartment to which it is admitted. Arrived at this point, and being one and a half times as heavy as air, it fills the compartment from the bottom up, without being diluted with the air, and produces intense cold by its expansion at the same time; while the pressure with which it enters forces it into all interstices in the cargo, driving out every particle of the air, which will all escape from the top, as no compartment on board ship is *perfectly* air tight. Knowing then the cubic contents of any compartment, and the cubic space occupied by the cargo in it, sufficient gas can be admitted as to render it absolutely certain that no fire can exist there without the necessity of opening the hatches to *see* if the fire is out, until such time shall have elapsed as to render it perfectly *safe* to do so. By shutting the cock in the main pipe the remainder of the gas is kept from vaporizing until such time as it may be required.

On arriving in port, the flask is disconnected from its pipe and sent to the gas manufactory (to be hereafter mentioned), where it can be refilled in a couple of hours, and on being returned is set up and connected in its usual place. Should no fire occur, the apparatus can remain intact for an indefinite length of time, except to see that the cocks are in working order occasionally. The liquid is entirely non-corrosive in its character, and the vapor is not injurious to any class of cargo; while it is, I think, the only substance that will permanently suppress the most advanced state of combustion in a cargo of coal.

It is, of course, well known that carbonic acid gas is the agent employed in the Babcock extinguisher and others of like nature; but in these the gas is produced on the spot by the action of an acid on marble dust or bicarbonate of soda. The objections to such an arrangement are that the apparatus is somewhat cumbersome and complicated, and the supply of gas is rather limited, unless a great number of machines are used; moreover, it must all be expended when once generated, and before a fresh supply can be obtained from any one machine, the apparatus must be cleaned out, and the requisite materials rearranged; while, in consequence of the moderate and varying pressure of the gas produced, a permanent system of pipes cannot be employed to carry the gas to any great distance from the generator. What I propose is simply to carry on board ship the gas itself in its most condensed form, viz., *the liquid*, of which one pound is equal to a trifle over eight cubic feet of pure gas. The liquid to be contained in vessels capable of withstanding the great pressure necessary to keep it from vaporizing at any temperature.

Until lately the use of liquid carbonic acid gas on the large scale has been prevented by two great difficulties: 1st. The want of an apparatus capable of producing a large quantity in a short time, and at a low cost. 2d. The want of suitable vessels to contain it at all temperatures. These difficulties have, however, been practically overcome at this station, although the *modus operandi* is not generally known.

W. N. Hill, the chemist of the station, has devised an apparatus for the generation and compression of gas, which is now in successful operation, and which produces *fifty pounds* of liquid gas per hour, at a cost of only *fifteen cents* per pound. This apparatus consists of a peculiar combination of generators and compressors, the former being manufactured for the station by John Matthews, of New York, and the latter by the Burleigh Rock Drill Company, of Fitchburg, Mass. To contain the gas, the manufactory of John Matthews has produced for us steel flasks of about the dimensions mentioned, which weigh but a little over three hundred pounds, and which have frequently been tested to two thousand pounds per square inch, hydraulic pressure. One of them (which was purposely tested to destruction) only gave way at the enormous pressure of

three thousand one hundred and thirty-two pounds per square inch, under which strain a jagged crack opened in the side allowing the water to run out. These flasks are made of *sheets of steel* rolled up like curl papers, one within the other; the outer one of all being riveted, while all spaces between the sheets are filled with *pure tin*. They have been kept constantly full of the liquid gas, which, at the present average temperature of their store room, exerts a pressure of between four hundred and six hundred pounds per square inch.

Thousands of flasks of only *one* thickness of one-sixteenth of an inch of sheet steel, lapped four inches, riveted and soldered with tin, have been made and sold by John Matthews for soda water purposes. They are constantly carried about New York and other cities to soda water dealers, containing, during their transfer, a pressure of carbonic acid gas of one hundred pounds per square inch. They are warranted by the manufacturer to stand three hundred pounds; they are tested to five hundred pounds, and their bursting strain is seven hundred pounds per square inch. The flasks at this station are made on the same principle, but, of course, have more layers of steel. For the purpose which I propose, there is no necessity for the extreme lightness which is necessary to their peculiar uses here (for the Lay torpedo boat), where all useless weight must be avoided. Their side walls are but about five-eighths of an inch thick, through steel and tin, and it would seem that by merely *building up* a flask on this principle, it can be made practically unburstable.

Liquid carbonic acid gas exerts a pressure on its containing vessel of about six hundred and ninety pounds per square inch at 42° F., eight hundred and fifty-five pounds at 60° F., and twelve hundred pounds at 86° F., and it is in consequence of this pressure that I have dwelt so particularly on the construction of the vessels which we have so far found suitable for containing it; it being, of course, both necessary and desirable that the fears of the community should be dissipated by showing practical results accomplished in overcoming the difficulties and dangers of any plan proposed for its acceptance. From our success thus far, however, in regard to these practical points, I do not think it chimerical to suggest the ultimate solution of the problem of a satisfactory fire extinguisher in the plan here proposed.

As previously stated, the result of the experiences of this station with regard to the manufacture and control of liquid carbonic acid gas is not generally known, and has never appeared in print; but I have not gone into the detail of the subject to any great degree, as a work on the subject is shortly to be published by W. N. Hill, which will contain full particulars with regard to our apparatus for generating and compressing, as well as descriptions of the mechanical structure of the flasks, stating the number of sheets of steel, mode of securing the heads, etc. etc.

U. S. Torpedo Station, Newport, R. I.,
March 9, 1875.

PREPARATION AND TESTING OF CYANIDE OF POTASSIUM.

BY DR. J. ENEU LOUGHLIN.

The preparation of cyanide of potassium for laboratory use is well worthy of special attention. A very good quality of cyanide is made by the following process:—

1. Purification of the carbonate of potassium. Ordinary salt of tartar ranges from 72 to 96 per cent. carbonate of potassium, the remainder being chloride of potassium and sulphate of potassium. The latter salt is very objectionable in the preparation of cyanide of potassium, as it is apt to color the cyanide from a light-gray up to a reddish-brown, passing through the intermediate stage of yellowish-red. All that is necessary to purify the salt of tartar is to dissolve it in its own volume of water, allow it to settle, pour off the clear liquor, and evaporate it rapidly to dryness in a clean iron crucible.

2. Recrystallization of the ferrocyanide of potassium, and drying the same completely by exposure to a gentle heat, yields a powder, which is a dirty, grayish-white, with a slight tinge of yellow.

3. Preparation of the cyanide of potassium. I use an iron crucible of half-litre capacity. Place it in a furnace, and heat to a bright-red heat. The mixture of equal weights of dried ferrocyanide of potassium and carbonate of potassium is projected into the red-hot crucible, half at each projection. The mass soon melts, becomes first pasty and of a black color, but gradually it becomes limpid, and assumes a light yellow color; a considerable amount of gas is evolved, and the color of the frothing is a very good index when the operation is finished. As soon as the froth is white, the operation is finished. A piece of dry, clean iron, dipped in the mass and brought out, shows the cyanide upon it to be of a pure white, if the operation was rightly performed. The heat is now slackened down a very little; the pasty mass of iron, in combination with some carbon, deposits upon the bottom, and the clear liquid cyanide of potassium is now ready for pouring. An ordinary iron pan, well polished on the inside, and thoroughly cleaned from rust by dilute hydrochloric acid, and scouring with sand, serves well the purpose of a receptacle for the liquid cyanide of potassium. It should be carefully poured through a fine mesh of iron wire, avoiding the dregs of settled iron. It should also be poured so as to form thin cakes, which are conveniently broken up. As soon as the mass is sufficiently cooled it is placed in well-stoppered (glass) bottles. By this method an amount of cyanide of potassium is obtained equal to the weight of ferrocyanide of potassium used. (It is called cyanide of potassium commercially; chemically it is a mixture.) It contains from 65 to 88 per cent. cyanide of potassium; is very hard, of pure white color, presents a partially crystalline appearance upon fracture, and is very deliquescent, evolving a perceptible odor of hydrocyanic acid. The

crystalline appearance becomes more and more perceptible as the amount of cyanide of potassium in the specimen increases.

Pure cyanide of potassium can be conveniently obtained from the above by breaking up moderately fine the cyanide, packing it in a glass percolator, and allowing bisulphide of carbon to pass through it. The bisulphide takes up the cyanide, "leaving the other substances present in the commercial cyanide." The bisulphide is allowed to evaporate spontaneously, or is driven off by gentle heat. The pure cyanide of potassium is deposited as a crystalline mass, which is kept in that state; or, as I much prefer, fused and broken up. A sample of cyanide, so prepared, will range from 97 to 99·2 per cent. cyanide of potassium. It is very deliquescent, evolving considerable HCy; not as hard as the commercial, has a more or less transparent appearance, and a very distinct crystalline structure.

In order to determine the value of commercial specimens, I purchased from several of the prominent Philadelphia manufacturers, and found the results to vary considerably. The method employed was Liebig's. A decinormal solution of nitrate of silver, containing

10·797 grms. silver in 1 litre solution.
1 CC = 0·0054 HCy = 0·013022 KCy.

This process is fully described in *Fresenius's Quantitative Analysis*, pp. 328, 329. Fifteen specimens of each were examined, $\frac{1}{10}$ grm. being the quantity operated on. These results were further confirmed by mixing the solution containing the cyanide of potassium with excess of nitrate of silver solution, then finally nitric acid in slight excess, allowing to settle without warming, and determining the cyanide of silver by collecting the precipitate upon a previously weighed filter, and drying at 100° C. until the precipitate ceased to lose weight. The names of the manufacturers are not given, for the reason that the samples of each party were sufficiently strong to be considered good commercial articles; the range was from 56 to 88 per cent. A sample of pure French cyanide assayed 94·2 per cent. There are several reasons for the great variations in the respective amounts of cyanide of potassium in commercial specimens.

1. I have found that perfect drying of the salt of tartar and ferrocyanide insures a product of much higher percentage than if the salt of tartar or ferrocyanide, or both, were not perfectly dry. If the ferrocyanide of potassium is not added in a dry condition, a loss of at least 5 per cent. KCy is produced. Addition of the salt of tartar in a slightly moist state produces a loss of 3 per cent. KCy; and the two materials added, in an undried condition, a loss amounting to at least 12 per cent. KCy.

2. The quicker cyanide of potassium is made, the better the product (higher the per cent. KCy); the less salt of tartar used up to a certain point, the quicker the operation is effected; the higher the per cent. KCy produced. We cannot with safety add salt of tartar beyond a certain point, or we will obtain a mixture that fuses with great difficulty, and which cannot readily be poured. If the salt of tartar or ferrocyanide contains sulphate of potassium, the resulting cyanide will be colored from a delicate pink up to a reddish-brown, according to the amount of the sulphate of potassium present. Refusion with one-third its weight of dried ferrocyanide of potassium, and one-fiftieth its weight of clean iron filings, produces a fine white product of high percentage KCy. I have obtained very good results by heating the salt of tartar in the pot to redness, and adding the dried ferrocyanide of potassium. The plan of first heating the ferrocyanide to fusion, and adding the salt of tartar, does not succeed so well. I cannot too strongly comment on the advantages of heating the pot to a red heat before the addition of the materials, or upon the drying of the materials and thorough mixing before their projection into the pot.

Jeff. Med. Coll., Philadelphia,
March 17, 1875.

A CONVENIENT APPARATUS FOR HOT FILTRATION.

BY H. CARRINGTON BOLTON, PH.D.

Read before the New York Academy of Sciences, May 10, 1875.

Every working chemist has experienced the need of a convenient apparatus for hot filtration. Hot saturated saline solutions which crystallize on cooling in the filter or in the neck of the funnel, and viscid liquids possessing the necessary mobility only so long as a higher temperature than the average is maintained, render the employment of some form of apparatus for hot filtration indispensable. While much attention has been given of late to the construction of apparatus for *rapid* filtration, as the innumerable forms of water pumps and steam injectors abundantly show, little has been done towards improving the existing forms of apparatus for hot filtration or the contrivance of new ones.

Two kinds of apparatus have come under our observation. The first of these, invented by Dr. Hare, is the well-known funnel support usually constructed of tinned iron with double walls and a conical aperture for inserting a glass funnel; the space between the walls being filled with water or other liquid, it is kept at a boiling heat by a lamp placed under a cavity shaped like an inverted funnel. A more compact form of the same apparatus was contrived by Plantamour, in which the metallic box is given the form of a cone, and heat is applied to a hollow cylindrical projection filled with the liquid employed, and communicating with the space between the double walls.

While this apparatus is well adapted to the use of pharmaceutists, or for the purposes of the manufacturer, it is not suited to the wants of the analytical chemist. The first form occupies much space, and both forms must be had in great variety of sizes to fit funnels of

various dimensions. A small funnel is nearly lost to view in a large jacket, and a large funnel is not heated by a small one. Then again, only well-made funnels, whose sides are inclined at an angle of 60°, will fit the conical opening. Moreover, the fact that the apparatus is constructed of metal is in itself a disadvantage. Only extraordinary care will keep the metal clean and bright in the atmosphere of a laboratory. This disadvantage could be largely overcome by nickel-plating the metallic box, but we have not seen this luxury introduced. In the filtration of liquids, giving rise to very acid fumes, the use of a metallic jacket is hardly admissible.

The second apparatus alluded to is that contrived by Dr. A. Horvath, and described in the *Annalen der Chemie und Pharmacie*, vol. 171, page 135, 1874. A tube of soft lead, one centimetre thick, is wound around a funnel in the form of a spiral, one end being connected by a tightly fitting cork with a flask placed at a convenient distance, and the other end of the leaden pipe communicating with a recipient for the escaping vapors. Steam being generated in the flask, it passes through the leaden tube and warms the funnel and contents. This contrivance may work well, but is not very convenient; the inventor strangely enough adds that by employing ether, alcohol, carbon disulphide, benzol, or aniline in place of water, filtration can be carried on at any desired temperature. The question naturally arises why select liquids having such low boiling points as ether (35·7° C.) and carbon disulphide (46·6° C.) to effect *hot* filtration; surely the cases are rare where the temperature could not be moderated, if desired, by generating steam less rapidly. Then, too, it strikes us that the atmosphere of a laboratory, where a dozen or more solutions are warming by the uncondensed vapors of carbon disulphide, would be anything but agreeable in its effect on the olfactors of the occupant! This suggestion of the respected author is apparently a case of pen-and-ink chemistry, rather than the result of practical experience.

There seems to be room then for a simple, cleanly, portable, and inexpensive apparatus for keeping the contents of a funnel hot while filtering, and it is believed that these requirements are filled by the new apparatus described in this paper.

The materials are found in any ordinary laboratory. Select a small funnel with a long stem, and a larger funnel with a wider throat, and cut the stem of the larger funnel short; slip a piece of India-rubber tubing of the required size over the stem of the smaller funnel, and then insert it in the larger one so that it fits water-tight. The inner funnel should project about half a centimetre above the edge of the outer, and as much below the stem of the latter as it admits. We have found the three sizes named below sufficient for all operations of analytical chemistry, though larger ones may be used for preparations.

Dimensions given in centimetres; the first figures give the greatest diameter of the funnel, and the second its length including stem.

	Outer funnel.	Inner funnel.
No. 1 . .	7 × 6½	4 × 10
No. 2 . .	10½ × 9½	6½ × 12½
No. 3 . .	13½ × 13	10 × 17

Steam generated in a flask of about one litre capacity and conducted by means of a glass tube into water filling the space between the two funnels, warms the filter on the inner funnel with its contents. In one experiment the water in the outer funnel marked a temperature of 97° C. and the liquid in the inner one 76° C. The temperature in the inner funnel may be greatly increased by covering it with a convex glass or by employing a saline solution in the outer funnel.

As a matter of course water condenses in the outer funnel, and must be removed from time to time. In the case of funnels No. 2 it accumulates at the rate of 30 to 35 c. c. in half an hour when boiling vigorously. This seems at first sight to be an objection, but the superfluous water can be so readily removed with a pipette or a siphon that it does not have much force. Or the accumulating water may be drawn back into the steam generator through diminished pressure by simply removing the lamp beneath the flask. In this case the end of the tube should plunge but little below the surface of the water in the outer funnel, else the latter will be completely emptied.

Actually the operator is not at all annoyed by the necessity of attending to this point, for the filtration requires his constant presence. Should the outer funnel be filled with distilled water in the outset, an overflow would not prove serious; since the inner funnel stands higher than the outer, any disturbance of the precipitate in the former by accumulating water is out of the question.

The great compactness and cleanliness of this apparatus make it available in quantitative analysis, and we have used it for some time with great satisfaction. After washing a precipitate on the filter it may be dried very speedily by simply continuing the heat; the dried filter removes easily, and so the two funnels once arranged need not be disconnected. It is true that this point holds good in any form of apparatus for hot filtration.

Other advantages will occur to those using the apparatus, such as the transparency of the outer vessel, the total absence of metal, and the increased rate of filtration consequent upon the higher temperature. The double funnel may be connected with a Bunsen water pump or other apparatus for rapid filtration.

In washing precipitates with hot water we have also found it feasible to direct the steam from a small generator directly into the filter itself; if care be taken to moderate the pressure, the precipitate is washed with hot distilled water without danger of loss by spattering, and this works almost automatically.

School of Mines, Columbia College, N. Y.,
April, 1875.

ON THE SALINE MATTERS WHICH THE BEET DERIVES FROM THE SOIL AND FERTILIZERS.

BY EUGENE PELIGOT.

Translated by J. M. Merrick, B.Sc.

The beets, started in the open air, were transplanted into pots, taking care to select roots of the same form and appearance. Having saved each year only two or three seed pods, I had some chance of experimenting upon the same variety. I have cultivated for two years past the seed of a single beet, and it is with plants raised from this seed that my experiments have been made.

My first experiments were undertaken with a view to determine the influence which different mineral matters have upon beets cultivated apart and in a soil of the same kind. Pots of about 30 litres capacity were filled with garden soil of ordinary quality. I have given in a previous essay the composition of this soil, which contained a considerable quantity of lime. Between the 1st of July and the 15th of October, 1871, Nos. 1 and 2 received at suitable intervals watering with water of the river Seine, containing one gramme of chloride of sodium to the litre; Nos. 3 and 4 the same quantity of water containing one gramme of chloride of potassium; Nos. 5 and 6 the same volume of water without any addition. Each of the first two lots received 30 grammes of salts.

After several weeks each pair of pots presented a peculiar appearance which distinguished it sharply from the next pair.

The shade, the size, and the stiffness of the leaves are the same for the beets submitted to the same treatment, different for those whose regime is different. The same fact was noticed in following years, so that the presence of saline matter employed in predominating quantity is sufficient to give to the plant an aspect which is peculiar to it.

The beets gave :—

	Weight of root. grammes.	Ash. per ct.	KCl in ashes. per ct.
No. 1 (chloride sodium) . .	572·2	·77	18·6
No. 3 (chloride potassium) .	571·5	·97	15·3
No. 5 (water only) . . .	721·8	·64	8·0

In this experiment the chlorides did but little injury to the development of the plant; the soil being suitably furnished with fertilizing materials. The roots were rich in sugar, containing about 15 per cent.

This result, which agrees with others furnished by the beets of Brittany, is in opposition to the generally received opinion that beets rich in alkaline chlorides are poor in sugar. These two facts are unconnected, for it is likely that the secretion of sugar depends upon the variety of the plant, while the absorption of saline matter, chlorides especially, is connected with the nature of the soil and the manure.

These chlorides, which the roots contain in sufficiently large amount, are found still more abundantly in the leaves, and the same is true of several other mineral substances which traverse the root with a rapidity varying probably with their nature, to accumulate in the leaves. In fact, while the dry root does not contain over 3 to 6 per cent. of mineral matters, the dry leaves losing 90 per cent. of water, give 25 to 32 per cent of mineral matter, and their ashes give from 23·7 to 73·5 per cent. of chlorides.

In my analysis the chlorine is calculated as chloride of potassium, for even in beets which have been watered with a solution of cooking salt, the potash is more abundant than the soda.

My experiments were reported in 1872 in almost identical conditions, the plants being watered from the 21st of July, to the 9th of October, with Seine water, containing 1 gramme of chloride per litre, for numbers 3, 4, 5, 6, and 2·5 grammes for 7, 8, 9.

The following table gives the composition of the roots :—

	Weight of beets.	Density of juice at 15°.	Ash per ct. in juice.	KCl in 100 parts salts.	Sugar in 100 parts juice.
	grammes.				
No. 1. (Water) .	680	1080	·83	7·1	15·3
" 3. (25 grm. NaCl)	635	1081	1·07	16·3	15·0
" 5. (25 " KCl)	650	1083	·89	13·2	14·0
" 7. (75 " NaCl)	682	1087	1·07	27·3	16·4
" 9. (75 " KCl)	645	1090	1·20	26·8	15·8

We see that the absorption of the chlorides increases with the quantity we put at the plants' disposal; yet it has its limits.

Since the last two beets contained only about double the chlorides of the two preceding, while they had been treated with three times as much salt or chloride of potassium, the other roots were used to determine how the mineral matters were distributed in the top and bottom of the same beet cut into three tolerably equal parts, the middle part being rejected.

The ashes were washed to separate the soluble from the insoluble salts.

The former are more abundant in the lower part of the root. As the chlorides and sulphates are soluble salts, it would seem that we ought to find them in greater amount in that part of the root which furnishes the most salts, but the contrary is the fact, and the differences are sharply marked, as is shown by the following figures .—

Beet	No. 2.		No. 4.		No. 6.		No. 8.	
	A	B	A	B	A	B	A	B
Upper part (neck) .	14·0	16·9	41·9	15·2	40·7	15 6	49.1	
Lower part . . .	4·7	8·9	16·3	8·0	15·3	6·0	23·7	

A represents the chloride of potassium and B the sulphate of potassium contained in 100 parts of salts.

It follows that the chlorides and sulphates which we find also in considerable quantity in the leaves are concentrated in the upper part of the plant. We know that their presence in the juice is the principal cause of the formation of molasses. In consequence of these observations it would seem that sugar makers ought to treat only beets from which a considerable portion of the top has been removed, provided, of course, that the tops can be utilized.

I have also compared, in regard to the distribution of saline matters, the central parts of the beet with its circumference, after the removal of the skin. The central tissues of the beet are notably richer in water and soluble salts. A beet whose central portion contained 11·4 per cent. of solid matter, contained 14·0 in its outer parts, the latter giving 7·4 parts of ash for 100 of dry tissue; the other 9·7. The ash of the central part contained about one-third as much soluble matter as the other, which, consequently, contains more lime and magnesia salts.

In pursuing these studies I was led the following year to cultivate beets in a very poor soil in order to determine as sharply as possible the influence exercised by the fertilizing material I introduced.

The garden soil was replaced by fresh soil from Gorches. This soil was poor, but siliceous, not very permeable to water, and cracking by drought.

The beets harvested on the 20th October, received between the 3d of July and the 7th of September:—

Nos. 1 and 2, 24 grammes of chloride of sodium, in Seine water, containing 2 grammes to the litre.

Nos. 3 and 4, the same weight of chloride of potassium.

No. 5, 36 grammes of nitrate of potassa (4 grammes to the litre).

No. 6, the same weight of nitrate of soda.

No. 7, 25 grammes of sulphate of ammonia.

No. 8, 35 grammes of sal ammoniac.

No. 9, Seine water with no addition of saline matters.

No. 10, 42 grammes of acid phosphate of lime (6 grammes per litre).

No. 11, 24 grammes of a mixture of the salts indicated by M. Jeannel, as particularly proper to the development of vegetables (phosphate of lime, sulphates of ammonia, and magnesia, nitre and chloride of potassium).

In the month of August, the aspect of the plants presented considerable differences.

The leaves of the beets 1 and 2 were little developed and had begun to turn yellow, and the same was true of Nos. 3 and 4; the leaves were very small, yellow, and crumpled. Although the alkaline chlorides are absorbed by vegetables, it does not seem that they exercise any useful effect upon vegetation when unaccompanied by fertilizing matters. Chloride of potassium acts no better than sea-salt. The action of alkaline nitrates, salts of ammonia, and phosphate of lime is altogether different. The leaves of the plants watered with solutions of these salts were dark-green, large, and very abundant. The beet which had received only Seine water, was very little developed, its leaves being yellow and small.

The 14th of October the general aspect is the same, the most beautiful vegetation being shown by pot No. 10 (phosphate of lime); next come the plants which had received the ammonia salts and Jeannel's mixture, then the nitrate.

On the 28th of October a part of the roots and leaves was weighed. The beet No. 10 was much the finest, the root weighing 932 grammes. Calling this 100 the others can be represented as follows:—

Nos. 5, 6, 7, 8	34·3 to 36·7
Nos. 1, 3, 9	6·3 to 13·4

The ashes furnished by these beets did not present any very considerable difference of composition beyond those differences already mentioned in the case of plants watered with solutions of chlorides, the saline residue left by the beet which had received the sulphate of ammonia, contained 9 per cent. of alkaline sulphate, or about double the normal quantity.

The beet No. 10, watered with a solution of phosphate of lime, gave an ash of the following composition, viz.:—

	Root.	Leaves.
Silica	·5	1·7
Carbonate of lime	5·3	27·7
Phosphate of iron	1·6	1·5
Bibasic phosphate of magnesia	8·0	8·5
Tribasic phosphate of potassa	29 8	5·9
Sulphate of potassa	5·4	6·4
Chloride of potassium . . .	4 8	6·5
Carbonates of soda and potassa	44·6	41·8
	100·0	100·0

In comparing this result with the composition of the ash furnished by the other beets, we see that the employment of soluble phosphate of lime, far from increasing the proportion of lime salts absorbed by the plant, diminishes it in a notable manner. In fact the ash of the other roots contained from 12 to 20 per cent. of carbonate of lime. As to the phosphoric acid the proportion is sensibly the same for all the beets; it is no larger for the beet watered with a solution of phosphate of lime.

This result leads us to look from a new point of view upon the part played by the earthy phosphates in vegetable growth. Admitting that it can be generalized like the other facts obtained in this research, and comparing it with the observations relating to other mineral substances, we see that this action varies with the peculiar nature of the salts, which in different degrees favor the development of plants.

Several, in fact, are absorbed without undergoing any modification; such are especially the alkaline nitrates which we find in nature in the roots and leaves. In an essay which I published in 1838 on the analysis of the beet, I determined in the crystalline state the nitre which occurs in roots too highly manured. The employment of nitrate of soda as a fertilizer is, with the northern sugar planters, the subject of serious complaint, that salt occurring in the juice and being the source of nitrous fermentations. The chlorides which are often introduced into artificial fertilizers, although their efficacy is much more doubtful, occur also in the plants. I think, nevertheless, that in most cultivated vegetables the chlorine which we introduce into the soil in the form of sea-salt is found in the ash in the state of chloride of potassium, as I have shown to be the case with beans. The alkaline sulphates, which can give rise in the soil only to soluble compounds, are met with equally in vegetables, although in much more limited proportion.

Phosphate of lime, which is, without contradiction, the most valuable fertilizing material, presents this peculiarity, that with an equal weight, a plant submitted to its action and put in the presence of a great excess of salt, contains *no more phosphoric* acid, contains *less lime* and *more alkaline salts* than a neighboring plant in ordinary conditions, the latter in fact remaining dwarfed, while the former presents a luxuriant growth, so that, in fine, the excess of earthy phosphate in the soil results in the abundance of the harvest.

These facts can be interpreted in the following manner: the phosphate of lime is decomposed by the alkaline salts, and the salts of magnesia which every fertile soil contains in quantity sufficient for the needs of vegetation; there is produced phosphate of potash and ammonio-magnesian phosphate. These two compounds are, in my opinion, the most direct expression of material life in plants as in animals. They are necessary to plants, as we know, for the production of seed, and they so aid in the preservation of the species. The ashes of the seeds contain, in fact, hardly anything but phosphate of potash and phosphate of magnesia.

It is impossible not to compare this action of phosphate of lime with that which belongs to another lime salt acting also as a fertilizing material for plants of another kind. I speak of the action of plaster upon artificial meadows. The experiments of Boussingault have established the fact that in the comparative examination of the ashes of clover treated with plaster and not so treated, the sulphuric acid and the lime occur in almost the same proportion in the one case as

in the other, but that the salts of potash are notably more abundant in those plants which have received the sulphate of lime.

We know that we are not yet able to explain in a manner satisfactory to all the useful effects of plaster. I confine myself therefore to comparing them with those produced upon other vegetables by phosphate of lime. —*Comptes Rendus.*

UTILIZATION OF AMMONIACAL LIQUIDS AND OTHER PRODUCTS FROM GAS WORKS.

BY PROF. EMILE KOPP.

Translated by S. Cabot, Jr.

The first part of this article is devoted to the treatment of the liquids from the "scrubbers," the only new suggestion being the addition of a small quantity of copperas to the gas-water previous to the distillation of the ammonia. This precipitates the sulphur as sulphide of iron. This distillation should be performed in an economical still (for instance Coffey's apparatus), and the gaseous ammonia should be put through properly constructed purifiers.

Prof. Kopp then turns to the so-called Laming's preparation. Laming's preparation consists of a mixture of sulphate of iron (copperas), and hydrate of lime. This mixture naturally forms sulphate of lime and protoxide of iron, which latter is quickly oxidized to peroxide. There is also a slight excess of hydrate of lime.

The already partly purified gas streams through trays covered with this mixture. Carbonic acid is absorbed by the excess of lime. Carbonate of ammonia gives with the sulphate of lime, sulphate of ammonia and carbonate of lime. Sulphuretted hydrogen gives with the peroxide of iron, first protoxide of iron and free sulphur, and later the protoxide of iron is changed to the sulphide. The sulphocyanic acid gives with the excess of ammonia, sulphocyanate of ammonia; and the cyanide of ammonia gives with protoxide of iron, cyanide of iron.

When the mass has become so saturated that no more impurities are absorbed, it is spread out in the open air and sometimes a little copperas is again added. By this means the sulphide of iron is oxidized to free sulphur and hydrated oxide of iron.

The mass is thus regenerated and may be used over again with even more effect than before, owing to the more intimate and chemical mixture of the components. It can be used over in this manner twenty to thirty times, until at last it becomes too much charged with foreign salts to be of any value for purification.

It is now submitted to a treatment with water, whereby the ammonia salts are washed out. The liquid by evaporation yields crystals of sulphate of ammonia, while the sulphocyanide remains in the mother liquor. (The sulphate of ammonia from Europe is sometimes so contaminated with sulphocyanide as to unfit it for use as a fertilizer. The sulphocyanide of ammonia might be treated with lime to set free the ammonia, and the lime salt used to obtain the sulphocyanide of copper, a salt much used in the preparation of aniline black; or, it might be changed to ferrocyanide by proper manipulation. S. C., Jr.)

The lixiviated residue now consists almost entirely of cyanide of iron, free sulphur, carbonate and sulphate of lime. This mass is treated with a boiling solution of lime sufficiently strong to decompose the cyanide of iron, but not to form any sulphide of lime with the sulphur. After filtering, the clear solution of ferrocyanide of lime is precipitated with a solution of sulphate of potash which throws down sulphate of lime as a precipitate and leaves ferrocyanide in solution, which is obtained by evaporation and crystallization.

The residue now consists of sulphur, protoxide of iron, sulphate and carbonate of lime. This is dried and roasted in ovens adapted to the purpose, and the sulphurous acid is conducted into lead chambers for the manufacture of sulphuric acid. The burnt residue is ochre (oxide of iron).

Laming's preparation is sometimes prepared with little, or even without lime, in which case the copperas is mixed with the natural oxide of iron (ochre), and the bye-products in this case are more easily obtained.

In Lybels' works at Vienna, 2,400,000 pounds of sulphuric acid and 1,000,000 pounds of ochre, beside ammonia salts and prussiates, are produced yearly.

11 Park Square, Boston, Mass.,
April 7, 1875.

DETERMINATION OF PHOSPHORIC ACID WHEN PRESENT IN MINUTE QUANTITIES.

BY E. DRANSARD, CHEMIST.

Translated by S. A. Goldschmidt, E.M.

When phosphoric acid is present in very minute quantities, nearly all methods, at present in use, for its determination, fail in accuracy. The method to be described is a modification of that of Chancel, rendering it applicable to the analysis of all substances containing phosphoric acid, no matter how small the amount present. We have usually found the employment of acid nitrate of bismuth unsuccessful, as it compelled the use of an acid solution, and, if the amount of phosphoric acid present was small, the addition of the bismuth salt, instead of giving a precipitate, only rendered the solution milky.

If, therefore, instead of acidifying, the solution is exactly neutralized with carbonate of soda, and then nitrate of bismuth added, we obtain a mixed precipitate of the phosphate and other compounds of bismuth. This precipitate is dried, calcined in a small porcelain crucible, then carefully and thoroughly fused with a small quantity of pure carbonate of soda and oxalic acid, and converted into phosphate of soda, while the reduced metal may be collected in a button at the bottom of the crucible.

This fused mass is dissolved in the smallest possible quantity of water, filtered, acidified with hydrochloric acid, and finally converted by the aid of an ammoniacal solution of chloride of calcium into tribasic phosphate of lime. This latter is treated in the usual manner.

The method described is especially useful in the analysis of rocks as well as in that of precipitated manganese employed in the manufacture of iron.—*Moniteur des Produits Chimiques.*

FACTS RELATIVE TO THE HISTORY OF INDIUM.

BY M. J. BAYER.

Translated by Josephine Chevalier.

The author, having made some investigations for the preparation of a notable quantity of the pure oxide of

indium, recommends the following process, which is founded on the property possessed by the soluble salts of indium of being precipitated completely by ebullition with sodium bisulphite, the metals accompanying indium being only incompletely precipitated under these circumstances.

To apply this process it will be convenient to operate as follows, in the preparation of the pure oxide of indium. Zinc blende, of Freiberg, which is the most productive source of indium, is treated with hydrochloric acid of commerce until it is almost completely dissolved. The solution being left in contact with the residue for twenty-four or thirty hours, the indium is precipitated in excess on the zinc; the solution of chloride of zinc is then decanted with care, and the precipitated metal of zinc not attacked is separated by levigation. A few drops of sulphuric acid are then added to dissolve the zinc chloride contained in the residue; the metallic precipitate is washed with boiling water, and treated with nitric acid, with the exception of a little stannic acid, all is dissolved; afterwards, sulphuric acid is added in excess, and without filtering is allowed to stand until the nitric acid is completely driven off. Lead is then precipitated in the form of sulphate, and if we add water, the other metals, *i. e.*, indium, zinc, cadmium, copper, and iron, are dissolved, in the form of sulphates with a trace of lead.

After washing the precipitate, which has been filtered, and adding to the filtered solution an excess of ammonia, the copper, zinc, and cadmium remain in solution, the indium and the iron are precipitated in the form of hydrates, with some traces of the preceding metals. The precipitate is thoroughly washed and dissolved in the smallest quantity possible of hydrochloric acid; then the solution is boiled with an excess of sodium bisulphite until the odor of sulphurous acid has almost entirely disappeared.

The sulphite of indium is completely precipitated in the form of a fine, white crystalline powder. This sulphite is gathered on the filter, and washed with warm distilled water, excluding it from the air, for fear that there might be formed an insoluble compound of iron; if such occurred, it would be better to dissolve the sulphite again and purify it by precipitation, after boiling with sodium bisulphite.

The sulphite of indium thus obtained may have a trace of lead sulphite and sodium sulphite, the latter combining easily with insoluble compounds of indium.

The impurities are removed by dissolving the salt in sulphurous acid, which leaves the sulphite of lead, filtering and boiling the solution after filtering; the sulphurous acid is driven off, and the indium sulphite is deposited in a state of purity.

It is a basic sulphite, the composition being expressed by the following formula: $(SO_3)3In_2 + In_2O_3 + 8H_2O$. This is calculated from the atomic weight 113·4, figures which result from the researches of Bunsen on the specific heat of this metal. The sulphite of indium is a white crystalline powder, very light, which is deposited in crystals, readily recognized under the magnifying glass, when its solution in sulphurous acid is allowed to evaporate spontaneously. It dissolves readily in acids, and gives off sulphurous acid. It may be employed for the preparation of other salts of indium. At 100° it loses $3H_2O$; from 100° to 260° it gradually loses the rest of its water. At 280°, it commences to lose some sulphurous acid; heated to redness it yields a gray-colored oxide, owing to the reduction of a small quantity of indium.

The insolubility of this sulphite allows of the separation of indium without this form, if we have care, however, to repeat the precipitation in the case of a great quantity of iron in the solution, as above stated. The author endeavored to form a nitrate of indium, by adding some chloride of indium to a solution of potassium nitrate. In the cold the solution remained clear. On boiling it, a white precipitate was formed, and nitrous acid given off. The precipitate was of the hydrate of indium, $In_2O_33H_2O$.—*Annales de Chemie et de Physique.*

ON THE SOLUBILITY OF PLATINUM ALLOYS IN NITRIC ACID.

BY DR. CLEMENS WINKLER,

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Translated by Charles McIntire, Jr., M.D.

It has been well known for a long time that platinum, insoluble by itself in a simple acid, is not able to resist nitric acid when in an alloyed condition, but becomes dissolved by it to a considerable amount. The oxidizable metal of the alloy enables the platinum to combine with oxygen, and that which, by the use of pure platinum, is obtained only with difficulty and by a roundabout process, follows here easily, and in a direct manner; the platinum forming platinic nitrate.

This observation calls to mind certain other phenomena, which are generally accepted, by which the condition of one body is able to influence a second depending more or less upon it. One thinks of, *e. g.*, the easy reduction of manganic oxides in presence of an excess of oxide of iron, the volatility of boracic acid in the vapor of water, or the breaking down of a soluble salt by an insoluble precipitate, etc.

Hence the solubility of platinum under known conditions is of analytical importance, and may of itself acquire a technical use; so, in accordance with my wishes, Mr. William Ohl, of Almsen, undertook, by an accurate research, to determine the amount of this solubility under various conditions.

For this purpose alloys of platinum with various metals readily soluble in nitric acid were prepared, and of course in various proportions; so that the amount of platinum contained approximated 1, 2·5, 5, and 10 per centum. The metals selected for this purpose were silver, copper, lead, bismuth, and zinc, being perfectly pure. 0·5 gramme of these metals was melted on charcoal by the blowpipe, and the properly weighed iridium-free platinum foil, in small clippings, was placed in the fluid metallic globule, where, by a renewed blast, it easily and completely dissolved into a homogeneous alloy. For the preparation of the zinc alloy the melting together was still conducted on a small scale, in a fire-clay crucible, set in the coal holder, under a cover of borax glass, thereby preventing any excessive volatilization of the zinc.

The metallic button so obtained was carefully cleaned from the adhering charcoal or surrounding borax, and again accurately weighed; the difference between this weight and the amount of the platinum used gives the amount of the other metal in the alloy.

As a solvent, perfectly pure nitric acid, free from chlorine, and the lower oxides of nitrogen, in different degrees of concentration, were used. The specific gravity of these was determined to be—

a. 1·398
b. 1·298
c. 1·190

In addition, experiments of solution were made with pure fuming nitric acid with a spec. grav. of 1·298.

The operation of the solution was conducted in the following manner:—

The alloys were placed in small glass flasks, covered with funnels, 17 c. c. of nitric acid were then poured on, and heated for several hours on a sand-bath, until no more red fumes were visible, and generally until the action of the acid had entirely ceased. The remaining undissolved portion of the platinum was, for the most part, separated in the purest state of division, in form a velvet-black powder, remaining suspended for a long time. The solution containing the residue was diluted by filling with water up to the neck of the flask, and let remain quietly, until it was certain that all the platinum had settled, which frequently took place rapidly, but again it required several days. Then carefully poured the liquid through a small filter, of which the weight of the ash was accurately known; finally emptied the platinum on it, and washed thoroughly with hot water. After drying, the filter was burned separately, and the platinum, after it had been ignited for a long time, was weighed. The resulting solution appeared yellow, from the presence of platinum; of a green color when copper was present; in many instances the amount of platinum dissolved was also determined as a check.

1. *Platinum and Silver.*

The alloys of platinum and silver are of a white color, slightly ductile, and with a streaked appearance on the surface. They are readily attacked by nitric acid, and produce yellow-colored solutions, with, at the same time, a separation of black finely-powdered platinum.

Spec. grav. of nitric acid.	Alloy employed. Per ct. of Ag.	Per ct. of Pt.	Per ct. of Pt dissolved.		Mean solubility.
A. 1·398	90·83	9·17	56·95	*a*	
"	95·42	4·58	69·28	*b*	
"	97 57	2·43	62·12	*c*	
"	99·24	0·76	75·00	*d*	65·84
B. 1·298	90·24	9·76	44·43	*a*	
"	94·96	5·04	57·46	*b*	
"	97·95	2·05	61·40	*c*	
"	99·05	0·95	70·00	*d*	57·82
C. 1·190	89·84	10·16	69.63	*a*	
"	94·59	5·41	50·66	*b*	
"	97·39	2·61	69·23	*c*	
"	98·96	1·04	75·80	*d*	66·27
Fuming.					
D. 1·298	90·44	9·56	37·45	*a*	
"	94·92	5·08	35·23	*b*	36·34

2. *Platinum and Copper.*

The alloys of platinum with copper are somewhat brittle, and furnish by treatment with nitric acid a greenish to a yellowish-green solution. The platinum residue is very finely divided, and settles in the liquid only after long standing.

Spec. grav. of nitric acid.	Alloy employed. Per ct. of Cu.	Per ct. of Pt.	Per ct. of Pt dissolved.		Mean solubility.
A. 1·398	90·24	9·76	45·60	*a*	
"	95·56	4·44	36·01	*b*	
"	97·80	2·20	51·78	*c*	
"	99·00	1·00	52·00	*d*	46·35
B. 1·298	89·89	10·11	26·57	*a*	
"	95·22	4·78	33·87	*b*	
"	97·57	2·43	40.32	*c*	
"	98·85	1·15	41·27	*d*	35·56
C. 1·190	90.61	9.39	11·19	*a*	
"	95·61	4·39	14·28	*b*	
"	97·38	2·62	30·37	*c*	
"	99·00	1·00	37·03	*d*	23·22
Fuming.					
D. 1·298	89·80	10·20	51·16	*a*	
"	94·78	5·22	40·81	*b*	45·98

3. *Platinum and Lead.*

Platinum is taken up by fluid lead very easily, and in large proportions, but it does not appear to effect so complete a combination as the alloys of the other metals. Since it appears, after the removal of the lead by nitric acid, not as a fine black, but as a somewhat thick grayish powder. The supposition that this anomalous condition is to be attributed to the presence of lead, is not tenable; by a sufficiently renewed treatment of the alloy with nitric acid, only a trace of the whole lead is dissolved. Still it is thus shown that a single treatment with nitric acid is not sufficient; especially when using concentrated acid, the fluid must be poured off, and fresh acid added, because, as soon as a layer of lead nitrate is formed, the further attack is hindered. On this account experiments with fuming nitric acid are useless.

Spec. grav. of nitric acid.	Alloy employed. Per ct. of Pb.	Per ct. of Pt.	Per ct. of Pt dissolved.		Mean solubility.
A. 1·398	90·20	9·80	7·19	*a*	
"	95·03	4·97	7·63	*b*	
"	97·41	2·59	22·14	*c*	
"	98 60	1·40	21·33	*d*	14·57
B. 1·298	90·46	9·54	9.09	*a*	
"	94·94	5·06	9·28	*b*	
"	97·48	2·52	16·78	*c*	
"	98·64	1·36	17·80	*d*	13·23
C. 1·190	88·75	11·25	8·33	*a*	
"	94·69	5·31	10·20	*b*	
"	97·44	2·56	11·42	*c*	
"	98·88	1·12	22·50	*d*	13·11

4. *Platinum and Bismuth.*

Bismuth, by heating, also dissolves platinum quickly and entirely to a very brilliant alloy. This alloy comports itself very similar to lead under treatment with nitric acid, leaving as a residue a part of the platinum in a quite compact, very granular form, quite free from bismuth.

Spec. grav. of nitric acid.	Alloy employed. Per ct. of Bi.	Per ct. of Pt.	Per ct. of Pt dissolved.		Mean solubility.
A. 1·398	90·00	10·00	13·87	*a*	
"	95·01	4·99	20·74	*b*	
"	97·40	2·60	25·36	*c*	
"	98·95	1·05	49·12	*d*	27·27
B. 1·298	90·04	9·96	19·31	*a*	
"	94·93	5·07	20·22	*b*	
"	97·02	2·98	41·51	*c*	
"	98·90	1·10	64·16	*d*	36·30
C. 1·190	90·07	9·93	4·48	*a*	
"	95·00	5·00	5·92	*b*	
"	97·56	2·44	8·46	*c*	
"	98·87	1·13	10·00	*d*	7·40
Fuming.					
D. 1·298	89·75	10·25	3·23	*a*	
"	96·84	3·16	18·40	*b*	10·81

5. *Platinum and Zinc.*

By melting together weighed pieces of platinum and zinc under borax glass, a very brittle bead is obtained, while probably 8 per cent. of the zinc is volatilized. These are very actively attacked by nitric acid, with a simultaneous separation of platinum.

Spec. grav. of nitric acid.	Alloy employed. Per ct. of Zn.	Per ct. of Pt.	Per ct. of Pt dissolved.		Mean solubility.
A. 1·398	90·00	10·00	10·29	*a*	
"	94·43	5·57	15·86	*b*	
"	97·38	2·62	16·23	*c*	
"	98·71	1·29	19·67	*d*	15·51
B. 1·298	90·46	9·54	10·70	*a*	
"	95 05	4·95	11·75	*b*	
"	97·47	2·53	24·42	*c*	
"	98·87	1·13	31·66	*d*	19·63
C. 1·190	89·84	10·16	19·40	*a*	
"	94·59	5·41	5·73	*b**	
"	97·80	2·20	19·25	*c*	
"	98·83	1·17	37·14	*d*	20·38
Fuming.					
D. 1·298	90·79	9·21	4·86	*a*	
"	96·74	3·26	10.76	*b*	7·81

If the results of the above experiments are compared with each other, the general conclusion can be drawn that the solubility of the platinum probably depends inversely as the amount of platinum in the alloy; thus, the smaller proportion of platinum present, in such a degree will the nitric acid dissolve a greater percentage of it. This appears with regularity in the alloys of platinum and bismuth. But in all the other cases there are so many deviations, that the conclusion can hardly be said to be strictly legitimate.

The degree of concentration of the nitric acid appears in a single instance, but not in all cases, to be of influence on the solubility of the platinum alloy. Leaving out of consideration the experiments made with fuming nitric acid, the mean solubility obtained by treating the different alloys with nitric acid of different specific gravities is given below.

* The experiment *b* shows a very anomalous result It was on this account repeated, and with entirely the same results. Thus it was found that 5·70 per cent. of the platinum in the alloy went into the solution.

Spec. grav. of nitric acid.	Platinum and Silver, per ct.	Copper, per ct.	Lead, per ct.	Bismuth, per ct.	Zinc, per ct.
1·398	65·84	46·35	14·57	27·27	15·51
1·298	57·82	35·56	13·23	36·30	19·63
1·190	66 27	23·22	13·11	7·40	20·38
Average,	63·31	35·04	13·64	23·66	18·50

Thus the degree of concentration of the nitric acid appears to have no important influence on the solubility of the alloys of platinum with silver, lead, or zinc. The action of the platinum-bismuth alloy is worthy of note; the solubility of the platinum-copper alloy decreases proportionally as the strength of the acid diminishes.

It must still be remarked that the metal least inclined to oxidize, silver, expedites, in the highest degree, in its combination with platinum, the solution of the latter; and that the results of the above researches do not agree with the assertion of H. Rose (*Hand. d. Anal. Chemie*, vi. Aufl. ii. 226), that only about 10 per cent. of the combined platinum is dissolved in heating a platinum alloy, rich in silver, with nitric acid. Elsewhere H. Rose asserts that the solubility of platinum increases considerably when the alloy of platinum and silver also contains gold (*Hand. d. Anal. Chemie*, vi. Aufl. i. 389). The presence of nitrous acid in the nitric acid appears generally to diminish the solubility of the platinum; and only in the alloys of copper was there remarked a considerable increase of the solubility when these were treated with fuming nitric acid in place of the pure nitric acid.—*Fresenius' Zeitschrift.*

ON A NEW VOLUMETRIC METHOD FOR THE DETERMINATION OF ZINC.

BY C. FAHLBERG.

Translated and condensed by Charles McIntire, Jr., M.D.

None of the many proposed methods for the determination of zinc in ores has obtained a general introduction, with the exception of the ordinary gravimetric method. The sodium sulphide method, as introduced into the Belgium Zinc Works, is inaccurate in the presence of other metals of the alumina and iron groups, and it is difficult to keep a standard solution of the sodium sulphide, even when using every precaution. Carl Mohr's method is too expensive for technical purposes, and is useless in the presence of manganese.

The author proposes to determine the zinc in a hydrochloric acid solution in presence of manganese and alumina by titering with a solution of potassium ferrocyanide, using a salt of uranium for an end reaction. Alumina is not affected by potassium ferrocyanide in this menstruum.

The author has found that manganese ferrocyanide in hydrochloric acid will be decomposed by zinc salt, the insoluble zinc ferrocyanide being formed. Nickel and cobalt form insoluble salts, but if present in small quantities as in the ores from the lower Harz, this may be neglected. Many determinations have been made with this method, in the presence of manganese, even as much as 20 per cent. being present. The greatest error was 0·2 per cent. The solution is made of such a strength that 1 c.c. = 0·01 gramme of zinc. To standardize dissolve about 0·5 grm. of pure zinc in hydrochloric acid and add of ammonium chloride five times the weight of zinc employed, this is to cause it to settle in fine flakes, and thus not surrounding any of the potassium ferrocyanide solution, and to settle rapidly. Should a little zinc be thus imprisoned, it will matter

but little if the solution is sufficiently dilute. It is best to use a burette with a glass stopcock and graduated in tenths; with every fresh addition of the potassium ferrocyanide take out a drop and test it with uranic nitrate, previously placed in drops on a porcelain plate, and as soon as all the zinc is changed to zinc ferrocyanide, the least excess of the reagent causes the known brown precipitate of uranic ferrocyanide to appear. Toward the end of the operation it is well to test after the addition of every five drops. The ordinary calculation will give the strength with a normal solution (1 c.c. = 0·01 grm.). 1 c.c. in excess represents an error of only between 0·2 and 0·3 per cent. if a Freiberg centner (3·75 grm.) is employed. This can be reduced by using a half normal solution, but too much dilution delays the end reaction, and makes it less sharp. With an exercise of patience the normal solution can be used and tested after the addition of every drop. The indicator is sufficiently delicate, as is shown in its reverse employment, in the determination of phosphoric acid by uranic nitrate.

To determine the percentage of zinc in an ore.—Dissolve in hydrochloric and nitric acids, add an excess of hydrochloric acid, pass sulphuretted hydrogen through, and filter out groups V. and VI. In the filtrate oxidize the ferrous oxide by nitric acid. and add ammonium hydrate in the cold; the iron is precipitated as a hydrate; all the zinc remains in solution. To remove any traces of zinc that may be carried down with the ferric hydrate, dissolve in hydrochloric acid and reprecipitate with ammonium hydrate and unite the two solutions for further treatment.*

Neutralize the ammoniacal solution with hydrochloric acid, add 10–15 drops of the acid (sp. gr. 1·12), in excess, and titer (unconcerned as to the presence of manganese) with the standard solution of potassium ferrocyanide, ceasing with the first appearance of a brown flake in the uranium nitrate.

The author then gives a table comparing the results of this method with the gravimetric method, which correspond very closely, varying from 0·49 per cent. more to 0·39 per cent. less than are given by the gravimetric method, in a series of eleven analyses, while in several instances they correspond within 0·20 per cent.

I think that titration with potassium ferrocyanide possesses many advantages over the known volumetric methods. It presents much to recommend it as regards rapidity and accuracy; 10–15 determinations may be carried on daily, and when the vexations attendant upon the use of the sodium sulphide method are considered, and how troublesome in preparation, then the potassium ferrocyanide is joyfully welcomed, since it is obtainable in a chemically pure state from any dealer in chemicals.—*Fresenius' Zeitschrift*, XIII.

REPORT TO THE TOWN COUNCIL OF BARNSLEY BY THE COMMITTEE APPOINTED TO VISIT LOCALITIES WHERE SEWAGE WORKS ARE IN OPERATION.

At a meeting of the Town Council, held on the first day of September, 1874, it was "resolved that Alderman Carter and Councillors Allen, Piggott, Johnson, Normansell, the town clerk, and the borough surveyor, be a committee to visit Birmingham, Coventry, and other places where sewage works are in operation, and report to this Council the result of their investigations with regard to such works." Your committee, in making this report, have been guided by the necessity of visiting as few sewage works as possible consistent with their duty in ascertaining the different modes adopted by towns in dealing with their sewage, and rendering sewage as pure as possible by the best known means of purification. Several boroughs and towns have been visited in the following order, viz.: Birmingham, Coventry, Leicester, Bilston, Leamington, Grantham, Blackburn, Leeds, and Doncaster. A general description of the several works visited will first be given, and then the report of the committee, and their conclusions, will follow.

Birmingham.—The sewage works of Birmingham are situate at Saltley, about two and a half miles from the centre of the town, to which place the whole of the sewage and rainfall are conveyed from every portion of the town by gravitation, and discharged into the tanks from two main outfall sewers. The population of Birmingham is about 350,000, and the dry weather flow of sewage about 8,000,000 gallons per day. The lime process was used for some time, but the tanks being far too small for the volume to be dealt with, and the whole of the works improperly carried on, they became a serious nuisance, and an injunction was obtained which compelled the corporation to take steps to provide a more complete defecation of the sewage. In 1871 the corporation introduced a bill into Parliament for the acquisition of certain lands on which to purify the sewage by irrigation. The bill, after passing through committee, was thrown out. The corporation then, under the advice of Mr. Hawksley, adopted a more elaborate system, based on the lime process. At the present time six tanks only are in working order, and twelve more are in course of construction. About a quarter of a mile above the settling tanks the sewage receives a quantity of milk of lime prepared in the works situate close to the sewer. These works consist of large sheds for the storage and slaking of lime, mixing rooms, and engine houses. The lime, after being slaked, is received into two large mixing tubs, and being plentifully supplied with water is agitated by steam power until the lime and water are thoroughly incorporated—forming what is called milk of lime—when it is run in a uniform stream into the sewers. As it falls into the sewers an apparatus is fixed which divides the milk of lime into small jets, and spreads it over as wide an area as possible. By the time the tanks are reached the lime has become thoroughly intermixed with the sewage, thus causing a more rapid precipitation in the tanks. In passing through the first tank all the grosser matter in suspension is precipitated, and the sewage then passes into two more tanks, where a considerable portion of the remaining suspended matter subsides, the effluent flowing over the weir into the stream, and so on into the river in a tolerably transparent condition. The tanks are used in duplicate, about a fortnight being occupied in emptying and preparing them for use again. The mud is drawn from the tanks by suction pipes, worked by steam power, to a well, when it is elevated into troughs and run into the sludge-drying beds, which are formed by throwing up earth embankments about two feet high, and after staying until nearly dry it is trenched into the land by manual labor. The land is then planted with cabbage and other crops, which thrive very well. Another

* If it is desired to determine the iron free from manganese, precipitate by ammonium carbonate, and after driving off the carbonic acid in the filtrate by means of hydrochloric acid, the solution is ready to titer.

mode of dealing with the sludge is being tried, viz., General Scott's cement process; by this a very useful cement can be obtained.

Coventry.—The city of Coventry has a population of 40,000 inhabitants, living in 8000 houses, and has a large number of water-closets. The dry weather flow of sewage is 1,800.000 gallons in twenty-four hours, and is now leased by the "Sewage Manure Company, Limited," the A. B. C. Manure Company having previously failed to purify the sewage. The sewage flows to the works by gravitation, and after being screened through Latham's patent sewage extractor, flows into a mixing well, where it receives a solution of sulphate of alumina, and is there agitated by steam power. It then passes into another well, where it is treated to a solution of milk of lime, and again agitated, passing thence into the receiving tanks, where it is allowed to settle. The Company have a few acres of land, which they irrigate with the effluent when the land requires it; at other times it runs direct from the tanks, along a broad open course (in order to oxidize it as much as possible) a distance of nearly half a mile before it reaches the river. Precipitation appears to go on for some time after reaching the river, and the bed of the stream for some distance further down shows a considerable deposit of flocculent matter. The sludge is removed from the tanks, and part of it aerated in Millburn's drying machines, after which it is sold as a portable manure. The drying at present appears to be very expensive, 10 cwt. of coal being consumed in drying 14 cwt. of mud; but arrangements are being made by which a larger quantity can be dried in less time, and also with less fuel.

Leicester.—The borough contains a population of about 105,000 inhabitants, and, being situate at a very low level and on a gravelly subsoil, a large volume of pure water finds its way into the sewers, which give an average discharge of about 4.000,000 gals. per diem. The sewage works are situate about one mile from the town, and were constructed in 1855 by the late Mr. T. Wickstead, C.E., on behalf of a sewage manure company, lime being used as the precipitating agent. Various alterations and improvements have since been made by the borough engineer, Mr. Stephens, C.E. The main outfall sewer discharges into a well at the works, from which the sewage is pumped a height of 20 feet into an agitating tank, where it receives a quantity of milk of lime, the quantity being regulated by means of a self-acting regulator attached to the engine. From the agitating tank the sewage runs into the first subsidence tank, which is 60 feet long, 45 feet broad, and 10 feet deep, the bottom sloping from the sides to the centre, where an archimedean screw is fixed to draw the mud (when the tank requires emptying) into a well, whence it is lifted by means of a bucket-pump into a shoot, which discharges into the drying beds outside the buildings. After passing through the first subsidence tank the sewage passes through a screen into a second tank, where it is allowed a further time to settle, and then flows over a weir into a filter bed composed of charcoal, gravel, and pebbles, and it then passes over other weirs, to allow of aeration into the river Soar. Two 20-horse Cornish engines are employed to pump, and one 10-horse power engine to drive the machinery, and agitate the lime and sewage when being mixed. The drying beds occupy about two and a half acres, each bed requiring to remain undisturbed about twelve months to dry, before being in fit state to be carted away. The dried mud is stated to be sold at 2*s.* 6*d.* and 3*s.* per ton.

Bilston.—The mode of purification adopted here is very simple, being merely subsidence and filtration. The town has a population of 25.000, with twenty or thirty water-closets, but has no manufactories of any description that discharge deleterious matters into the sewers. The whole of the sewage and the rainfall pass into the same sewers, which discharge themselves into the tanks by gravitation. The works, situate about a mile from the town, are in duplicate, and consist of receiving tanks 30 feet by 12 feet, the sewage passing on into a settling tank 50 feet by 33 feet, then through pipes filled with straw to retain any floating matter, into a chamber 12 feet by 33 feet, passing thence into the first filter-bed, which has an area of 1485 feet. The filter is formed by laying a perforated wooden floor, 15 inches below the surface of the water, on which is laid 9 inches of engine ashes, through which the water passes upwards. From this the supernatant liquid falls over a wall into another subsidence tank 92 feet by 33 feet, overflowing into a second filter 45 feet by 33 feet, constructed like the first filter, thence by downward filtration into another small tank; here it passes over a weir 33 feet long upon a water-wheel, the width of the weir, which splashes the water into thin jets. The dry weather flow of sewage is about 300.000 gallons per day. From 15 to 20 tons of mud are deposited weekly, chiefly composed of road detritus, which is lifted by manual labor out of the subsidence tanks on the land, where it is allowed to dry. Two men are employed and do the whole work, the tanks being cleaned out about once a fortnight. The effluent appeared to be very satisfactory, especially considering that no chemical or other defecating agent is employed. The Canal Company are desirous of taking the effluent to store for the purposes of navigation. No complaints have been made. The total cost of the works complete, which are of an experimental character, is stated to be £800, exclusive of land or outfall sewers, and the cost of working about £150 per annum.

Leamington.—The Leamington sewage works not only receive the sewage and rainfall from Leamington, but also the sewage and rainfall from the two adjoining districts of Lillington and Milverton, the combined area having a resident population of about 30,000, and the whole district being completely sewered. Originally, the lime process was adopted, but not giving satisfaction, the A. B. C. Company were, in 1869, permitted to experiment with their process. They failed to purify the sewage to the necessary standard, when steps were taken by the authorities with a view to irrigation. Lord Warwick, having a home farm some two miles distant, offered to take the whole of the sewage on a lease for thirty years, delivered by the local board, for which he agreed to pay £450 per annum, and he was also to take the responsibility of all legal proceedings, in case the effluent should prove a nuisance. The districts of Lillington and Milverton pay £600 a year between them. The local board have erected two 60-horse power engines, capable of lifting 2600 gallons per minute; the height to be pumped being 132 feet, and the length of the rising main 2¼ miles. The farm consists of 400 acres, 250 of which are under irrigation. The ground is of a gently sloping character, the subsoil being chiefly of a gravelly nature, and the farm altogether is naturally very favorably situated for irrigation. It is laid out on the catch-water system, except where very flat, in which case the ridge and furrow system is adopted. Unlike the Romford, and other similar farms, the main carriers are under the surface, and composed of fire-clay pipes,

so that, except the presence of manholes and outlets, there are no signs of sewage whatever. The grass and crops growing at the time of our visit appeared to be in splendid condition. The rye grass, we were informed, is cut eight times per annum, and the average weight is five to six tons per acre per cutting. The mangolds are of a superior size, as may be inferred when it is stated that the yield will be from forty to fifty tons per acre. The sewage is effectually disposed of and thoroughly purified; the effluent being bright, and possessing nothing noxious or unpleasant to the taste.

Grantham.—The borough of Grantham contains a population of 14,000, and the inhabitants, with the exception of one or two agricultural implement manufacturers, are engaged almost exclusively in agricultural pursuits. The town is well drained, has a good supply of water, and a large number of water-closets. The sewage and surface water are received into the same drain, and flow by gravitation to the sewage works, which are situate about a mile and a half from the centre of the town. The works were originally constructed to deal with the sewage by Hille's process, but appear to be very small for the volume to be dealt with, only holding two hours' discharge in dry weather. They are constructed in duplicate, and consist of four tanks 190 feet long, 18 feet wide, and 5 feet deep, these being again subdivided by division walls forming screens and thin filters. Hille's process, which consists of treating the raw sewage with a solution containing principally salts of iron, was in force up to about three months ago, when it was abandoned, on the ground of cost. In other respects the results are stated to have been very satisfactory. At present the sewage is flowing through the tanks, and some portion of the heavy suspended matter subsides, otherwise no purification whatever is attempted.

Blackburn.—This borough has had a bitter experience of the sewage difficulty, having been engaged in expensive litigation for sixteen years before a satisfactory result could be obtained. The town has a population of 80,000, and has been thoroughly sewered. The sewage and surface water are received into the same sewers, but provision has been made by storm overflows, at favorable places, to relieve the sewers in case of heavy falls of rain, each of these storm overflows being connected immediately with a stream. After an injunction had been obtained against the authorities, works were constructed for dealing with the sewage by the lime process. These works consist of five tanks, each 195 feet by 14 feet, covered with planks, four tanks being in operation at the same time, and one being cleaned out. These tanks are subdivided by low walls, in order to prevent the mud from being disturbed by the motion of the water above. The effluent from this process was so unsatisfactory that proceedings were again instituted against the corporation for polluting the stream. It was then decided to try the process of sewage irrigation, and for this purpose the council obtained parliamentary powers in 1871 for the compulsory purchase of land, and the establishment of a sewage farm near Plesington, about three miles distant from the town. The corporation took powers to purchase or lease 1000 acres of land, and to borrow for these purposes upwards of £200,000. Some 300 acres have already been purchased, and the sewage is now being utilized upon 180 acres. After leaving the lime works—which are still continued—the sewage runs to the farm by gravitation. Another farm of considerable extent, 1½ miles further away still, is about being acquired, to which the sewage will also gravitate. The subsoil of the farm under cultivation is almost entirely sand and gravel, upon which, previous to the sewage being used, scarcely anything would grow. At the time of our visit, the crops appeared to be very healthy, and the weight far above the average of farms not irrigated. The cattle are entirely fed on sewage-grown food, and are in good condition. The farm is laid out on the catch-water system; all the feeding-pipes are under the surface of the ground, as at Leamington, thus preventing the unsightliness of trestles and troughs.

Leeds.—The borough of Leeds comprises a population of 260,000 and almost all kinds of manufactures are carried on. The borough is not as yet thoroughly sewered, the injunction restraining the corporation from increasing the pollution until the sewage from the present sewers has been dealt with. The outfall sewer terminates by its junction with the river at Knostrop, which is about 2¾ miles from the town, and at this point the purification works have been constructed. The corporation some time ago entered into an agreement with the A. B. C. Co. to purify the sewage, which has been discontinued; and latterly experiments have been made by several patentees of chemical purifyers, amongst whom was Mr. Goodall, whose system is now about to be adopted. Twelve new tanks have been constructed, each 100 feet by 60 feet, capable of holding one day's discharge, and are so well designed, that eleven can always be at work whilst one is being emptied. The sewage will be pumped by centrifugal pumps from the main outfall sewer, a height of 14 feet, into a large iron cistern, where the chemicals will be mixed with the sewage, and the whole agitated. From this cistern the sewage passes into the tanks before mentioned, where it is allowed to subside, as it slowly moves through each tank, and finally, after passing 1200 feet, in distance, flows over a large bye-wash and aerating weirs into the river. Arrangements are also made in each tank that when the supernatent liquid is being drawn off, the last foot, which is generally little better than the sewage itself, will be returned to the pumps and so treated again. The works are not quite completed, and will not be in operation until the 1st of October next, when it is expected that all will be ready.

Doncaster.—Here, as in other towns where sewage purification works exist, legal proceedings were instituted against the authorities for the pollution of the river, when steps were taken by the corporation to remedy the evil complained of. The population of the borough is about 19,000, all contributing to the sewage, the dry weather flow is 700,000 gallons, or nearly 40 gallons per head; the sewage, therefore, is very weak. Previous to the injunction the sewers discharged themselves into the river at various points; but they are now intercepted by the construction of a new intercepting sewer, and deliver at one point. Here a pumping station has been erected to lift the sewage a height of 52 feet to the farm 2¼ miles distant, the principle of dealing with the sewage by irrigation having been adopted by the council. The farm is the property of the corporation, and with the homestead, and two or three laborers' cottages, has an area of 260 acres, 132 of which are under irrigation. The farm is leased to Mr. Brundell for a period of fourteen years, at the yearly rental of £800, the corporation delivering the sewage at the farm. The soil for the most part is of a very light sand and gravelly nature, consequently very porous. No underground drainage has been attempted, except in the hollows. The sewage is distributed to

the various parts of the land by underground carriers, as at Leamington, nothing being perceptible but the manholes for letting it upon the land. When not required on the land a reservoir has been constructed into which the rising main discharges, and where it is stored until wanted. The sewage is pumped upon the farm without any previous subsidence or precipitation whatever, with the exception of a screen, which prevents any very large substances from getting to the pumps, Mr. Brundell believing that the sediment deposited on the land by the sewage will materially assist the soil, which is of an open nature. The grass grown on the farm is estimated to yield 40 tons per acre per annum, and the turnips, cereals, and other crops are expected to do equally well. Experiments are being made with the sewage on kitchen garden produce, and a very fair result is expected. A considerable number of sheep and cattle are fed on the farm and appear to be in very good condition. No disease has at any time been detected, thus proving that sewage-grown food is as pure as produce grown under ordinary farming.

Your committee, having carefully considered the subject, with the aid of such information as their visits to the different places have enabled them to collect, are led to the conclusion that additional experience is yet wanting, before the difficulties which attend the sewage question can be said to be fully overcome. The diversity of systems, and comparative perfection of some of the works they have inspected, reveal to them, that in precipitation, irrigation, or in the two combined, a solution may be found for the problem which seems to embrace the great sanitary questions of the age. The sewage products of every town will vary, according to the industrial pursuits, and sanitary arrangements provided for its residential population; and in its relation to the irrigation system especially this variation should not be overlooked. It seems possible, however, to exaggerate the importance of this variation, so far as the fertilizing properties of the sewage extend. And although the prevalence of water-closets, or the dependence upon what is termed the "midden" system for the removal of excreta, may affect the question to some extent, the gross products of "midden," as compared with water-closet towns, do not present so striking a contrast as regards chemical matters in solution, and in respect of which even the best systems of precipitation appear to produce but little change or alteration. Topographical position, also, or the relation in which a particular town is situate with reference to its suburban facilities, is a second prominent question in considering the applicability of irrigation expedients. If difficulties in gravitation arise, they can be surmounted by resort to mechanical means for raising the fluid; and the question thus becomes narrowed to one of obtaining, within reasonable limits, an adequate and suitable area of land to which irritation may be applied. And here it must be observed, that so far as the most perfect results are likely to be obtained, in the best constructed works your committees have visited, the effluent water will hold in solution certain chemical properties, which, although inoffensive to sight or smell, can only be effectually removed by contact with earthy filtration, as the irrigation system provides. The primary question, however, in dealing with the difficulties of sewage products, is that of reducing their offensive character, so that their fluid portion may be discharged, with a given degree of purity, into, and form part of, the natural drainage of a district. From the observations your committee have made of the several important works they have visited, and from all the information they have been able to gather on this important, and confessedly difficult subject, they are confidently of opinion that amongst the various processes of precipitation, that of lime is the most economical and effective, so far as chemical and engineering science have hitherto been productive of practical results. It would be invidious and perhaps presumptuous in your committee, if they were to discuss in detail the merits or demerits of the different works and systems to which their attention has been directed. Suffice it to say the results to which experience in the different towns they have visited has contributed, all point to the same conclusion, and wherever the works have assumed a permanent as against a merely experimental character, they have uniformly been used, and are intended to be conducted upon the lime system of treatment. The Birmingham works, because of their magnitude, and the enormous expenditure in time, money, and skill upon their design and execution, are necessarily those to which your committee may direct more special observation. The works, though but partially constructed, are sufficiently completed to exhibit the treatment of a portion of the sewage upon the principle intended to apply ultimately to the whole sewage of the town: and it is scarcely possible to conceive a more simple, or effective process, for divesting the sewage of all suspended matter, and obtaining a more satisfactory effluent by precipitation than that discharged from these works. Your committee are unable to say how far the present effluent may satisfy all the future desires of the Birmingham Corporation on the one hand, or the owners of property below their works on the other. There is, moreover, an agricultural value in the effluent water, which it is thought the corporation may utilize by irrigating the extensive tract of land of which they have become the purchasers, and upon part of which their works are now being erected. The process of precipitation is attended with other results than that of obtaining a satisfactory effluent from the tanks in which the process takes place; and to these results, displayed in the form of sludge or saturated mud, serious attention must be given. So far as the acquisition of this mud is attendant upon the lime process of precipitation, no offensive smell is apparent; but, as part of a system of sewage treatment, a great nuisance may arise from its prolonged detention and exposure. In the earlier development of the Birmingham works grievous nuisance originated in this manner. The evil has been for the present overcome by disposing of the mud as it is produced. It is now conducted to given portions of the corporation estate, and there buried or "trenched in," the surface soil being first removed, and afterwards replaced upon the deposited mud. Such an operation, although unattended by any offensive smell while all is fresh, and the mud of immediately present production, is obviouely to be regarded as of temporary character only. The Birmingham authorities have contemplated another mode of appropriation, by converting the mud into cement, upon the principle of General Scott's patent. Here, however, difficulties again arise in the treatment of the "mud," inasmuch as it cannot be used in the cement manufacture until it has been brought to a condition of dryness fit to be burnt in an oven or kiln. The foregoing observations with regard to Birmingham apply in principle to the uncompleted works at Leicester and Leeds, which works are not specially commented upon, being accepted as further examples of the precipitation system already dwelt upon. In

every instance of precipitating works visited by your committee, the disposition of the precipitated mud has been found the turning point of difficulty and expense. Its manipulation in every stage is a source of trouble and cost, increasing as the process of deposition is being accomplished; and it is precisely at this point of the discussion where the question arises as to the practicability and expediency of combining the two systems of precipitation and irrigation; the former being relied upon for divesting the sewage of the coarser and heavier portion of the mud, and the latter being made the medium for transferring the lighter particles to a soil where their presence would be rather useful and fertilizing than otherwise. The fluid portions of the sewage, enriched by the fertilizing properties held in solution, would be entirely clarified by being passed through the pores of the irrigated soil, or assimilated by the vegetation growing upon its surface. The example of Blackburn may be quoted as affording valuable testimony in favor of the combined system. Precipitation has for a considerable time been carried out there, and a well-arranged system of tanks, possessing every advantage of capacity and form, has been in use for obtaining an acceptable effluent. But the conditions required from such effluent, in its admixture with the general drainage of a somewhat cleanly district, have imposed upon the corporation of Blackburn a more complete manipulation, and resort has at once been had to irrigation for effecting the more perfect result which their precipitation works had failed to realize. Eighteen months only have expired since the irrigation works were adopted, and already the area has proved far too limited. Enough, however, of agricultural success has followed to influence the corporation in their fidelity to the principle of irrigation; and they are now extending their powers for obtaining compulsorily an additional area of two to three hundred acres of land, to which their effluent water will gravitate at a distance of one and a half to two miles further along the valley, and at least five to six miles from the tanks, where the effluent water is first discharged at Blackburn. It will be seen that in the system just described gravitation has supplied all the means of transport, and that the hopeful prospects of the Blackburn Corporation are not marred by the constant expenses attendant upon the expedients of a pumping machinery. That pumping appliances do not, however, interpose any insurmountable obstacle to the transport, and dealing with sewage products, your committee may refer, with special interest, to the works they have inspected at Leamington and Doncaster respectively. In both these instances the sewage is conducted to a point in the immediate suburbs of the town, and, without any further treatment than is implied in collecting it for convenience of the pumps, it is at once forced along iron main pipes to the elevation and distance required for reaching the lands upon which it is to be distributed. With regard to these two towns the sewage may show a minimum of solid matter in suspension; and to this in some degree may be attributed—as regards Leamington especially—the absence of any direct complaint, of surfeiting the land, by the accumulation of mud on its surface. At Doncaster the works have only been in operation about eighteen months, so that a sufficient test can hardly be said to have been made of the evils or otherwise, of injurious and offensive surfeiting. It is obvious, however, that if a quantity of heavy mud is left on the surface, after absorption by the soil of the liquid portion of the sewage, such mud by exposure to light and the heat of the sun will occasionally become offensive.

The conclusions your committee have come to with respect to the treatment of the sewage of Barnsley may be summarized as follows: (1) That the item of profit cannot be associated with the results of any of the known systems of treatment of sewage, and the question must therefore be regarded as one of practical loss. (2) That precipitation processes are identified with various chemical mixtures and ingredients, but the milk of lime seems the most active and economical agent in the promotion of a fairly satisfactory effluent. The deposition of a vast and all but valueless, mud or sludge, is common to all processes of this nature. The removal of this mud from the tanks, and its subsequent handling and deposit in order to extract the vast proportion of water it combines, involves a great amount of labor and expense, and adds to the heavy cost at which suitable permanent tanks require to be constructed. We have thus an expenditure upon practically unproductive works—clarified effluent only excepted—combining (*a*) cost of tanks, with engines, pumps, and other apparatus for mixing precipitants; (*b*) cost of lime or other chemical precipitants; (*c*) cost of labor to engines and tank processes, including pumping from tanks, and handling to promote drying; (*d*) cost of coals for engines, etc. etc. (3) That irrigation presents an opportuity of diminishing some of the sources of loss, and provides a more certain guarantee for future immunity from complaint or litigation, by discharging the effluent water after contact with vegetation and filtration through the soil. The system must be debited as follows: (*a*) Cost of conveying sewage to a suitable farm; (*b*) cost of pumps, and expense of pumping of water to required level; (*c*) cost of drainage and preparation of surface of farm; (*d*) cost of rent of land, etc.; and credited, as against these items, with additional value of land for agricultural uses, from advantages of irrigation. (4) That irrigation depends for its application upon suitable land being available, whereon the process can be conducted without detriment to the salubrity and comfort of the surrounding locality. The situation of such land, and the practicability of conveying the sewage by force of gravitation, or its dependence on mechanical appliances for its transit, are important; although the cost of pumping to a moderate elevation is not to be regarded as a very serious item of expenditure, all other conditions being favorable.

With these conclusions before them, your committee have examined the district surrounding Barnsley, as to the existence of suitable land upon which the sewage of the town might be applied; and they are decidedly of opinion that appropriate areas exist, and that, both as to situation and quality of soil, selections might be made, which, from their convenience and adaptability, ought seriously to affect the determination of the question. For the present, therefore, they cannot recommend the council to persevere in the scheme of simple precipitation, as propounded by the plans for Barnsley, submitted by Messrs. T. and C. Hawksley. In those plans and the system of treatment they illustrate your committee would have felt the utmost confidence, providing no convenient facilities for irrigation had been at hand. Your committee, in making this recommendation, are impressed with the conclusions set forth on great practical authority, to the following effect:—"The right way of dealing with the subject is, first, to defecate the sewage by means of one or other of the best precipitating processes, and then to use the clarified water upon the land, if it be thought desirable, and if

not to discharge it into a neighboring watercourse. In this manner the defecation may be so conducted as to suit the special requirements of the case; for if effluent water is to be employed for irrigation purposes, there is no need of such a careful and perfect disinfection of the sewage, as when the water is to be at once discharged into a neighboring stream." Such facilities for irrigation existing, however, and considering that the quality of the effluent may be placed beyond the possibility of fair and reasonable objection—and also considering that if irrigation be practicable, a vast and important fertilizing power would be utilized which otherwise would be absolutely wasted, your committee recommend a more mature consideration of the whole subject before any further steps are taken for carrying out the works; and they are firmly of opinion that a scheme may be devised combining precipitation or subsidence of the grosser matters in suspension—in which condition it is thought the mud would be most favorable for manufacture into cement—with a subsequent use of the sewage water for irrigation purposes, which would meet every desired purpose, and greatly economize the financial resources of the borough. Your committee are fully sensible of the engineering details involved in the proposition to which their inquiries have led, and they feel how much the future success of the works depends upon the proper and skilful treatment of such details. Were this the proper time and place for further illustration of their views, your committee might have dwelt at greater length upon the recommendations they have made, and the interest and purposes affected by it. The council will feel, however, that such illustration will be forthcoming when required, and in the mean time your committee have only to discharge the remaining very agreeable duty of recording the deep obligation under which they have been placed by the great courtesy and confiding attention shown to them in every borough and town they have visited. They have had in each instance the gratification of being met by responsible official gentlemen, for whose attention and personal kindness they cannot feel too grateful.

Richard Carter,
John Normansell,
Josh. G. Johnson,
Henry Pigott,
Wm. H. Peacock,
Town Clerk.
E. Kenworthy,
Borough Surveyor.

Barnsley, September, 1874.

—*The Engineer.*

EARLY INDICATIONS OF SPECTROSCOPY IN AMERICA.

PAPERS BY DR. DAVID ALTER IN 1854 AND 1855.

To the Editors of the American Chemist:—

I have recently had occasion to become aware of the fact that American chemists generally did not know how much had been done in our country by one of their own number, in anticipation of the wonderful inventions and discoveries of Bunsen and Kirchhoff, in the use of the spectra of the flames of divers metals, as well as of hydrogen and other gases in an analytical way.

Happening to notice that the papers on these subjects published in 1854—three or four years before Bunsen's and Kirchhoff's discoveries appeared—by Dr. David Alter, of Freeport, Pennsylvania, were not referred to at all in the admirable digest of the labors of American chemists by Prof. Silliman, which has been given in full in your journal, I have mentioned the matter to several of our most distinguished chemists, and have not as yet found one who knew of the papers to which I now call your attention.

These papers will be found in the *American Journal of Science* for November, 1854, page 55, and March, 1855, page 213. As, in our conversation on the subject, you informed me that you intend reproducing these papers in full, I shall not attempt any analysis of their contents, but let them speak for themselves to your readers.

I desire to add that I am not to be understood, in directing attention to this matter, as wishing to detract in any way from, or even referring in any way to, the well-known claims of another illustrious American chemist—Dr. Draper—claims whose justice I fully admit. My only object is to bespeak justice for an American investigator who seems to have been overlooked. Dr. Alter was also noted for his success, I believe, in connection with the early manufacture of *bromine* from bitterns of mineral waters, but of this I have no detailed information.

Respectfully,
Henry Wurtz.

Art. VI.—On certain Physical Properties of Light, produced by the combustion of different Metals, in the Electric Spark, refracted by a Prism.

BY DAVID ALTER, M.D., OF FREEPORT, PA.*

We are indebted to the celebrated M. Fraunhofer for the fact that the Solar Spectrum is crossed by numerous fixed lines, and that the light of some of the stars differs from that of the sun in the number and situation of these lines.

In order to see some of these lines without the aid of a telescope I ground a prism of flint glass, with large refracting angle (74°). Viewing a fine slit made in sheet brass, when the source of light was the sky, nearly in the direction of the sun seen through this prism, I could count twelve or thirteen of Fraunhofer's dark lines. In viewing the blaze of a lamp, burning petroleum, I could discover neither dark nor bright lines, although I narrowed the light by passing it through the fine slit of sheet brass. I then tried the blaze of a tallow candle, when I could distinctly see an orange image of the blaze and one of faint yellow and one of green at the base of the blaze. The base of the orange image appeared to be the reflection of the light without any dispersion. When the brass with the fine slit is held in a horizontal position and the refracted light, seen through it, is from the base of the blaze, bright bands, one of orange, one of yellow, one of green, one of blue, and one of violet, are seen.

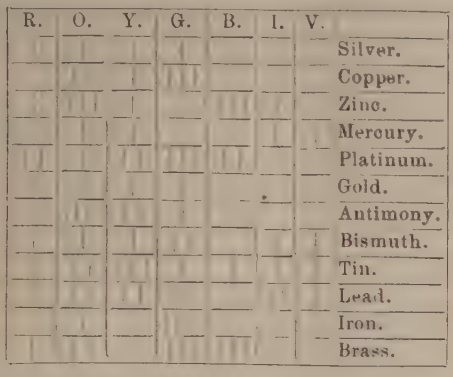
The flame of alcohol is the same, except that the orange band is wanting. A slip of white paper shows the same bands when illuminated by a tallow candle. The jet of a blowpipe shows the five images still more distinctly.

The light from heated wire or charcoal shows no peculiarities. The electric spark from a Leyden jar gave several bright images, which from optical illusion (perhaps from their brilliancy) appeared to extend beyond the sides of the spectrum, causing it to appear serrated along the edges.

But the most interesting effect of refraction is from the spark caused by breaking the galvanic circuit, or at the break of a powerful magneto-electric machine. The

* Am. J. Sci., xviii. 1854, p. 55.

machine I used produced sparks nearly a half an inch in length. These sparks, viewed through the prism, appear almost wholly resolved into separate, colored bands, as illustrated in the annexed figure, where R is the red extremity of the spectrum, and V the violet.



Thus in the silver, there is in the orange a very bright band, one of yellow and one of green—two faint bands in the blue which are not always seen, and are probably caused by an impurity of the metal. The light which is not resolved into these bands is very faint except in the red.

The copper has two in the orange and three in the green—the other light appearing most distinct in the red and yellow. In the zinc there is a strong band of red, two of orange, and three of blue with a faint yellow. The lead has two bright orange, and two in the yellow, nearer the orange than appears in the silver, then faint green bands and one bright violet, at the extremity of the spectrum.

Tin has a faint red, two of orange, three faint yellow, and a very faint green band, and also one of blue, indigo, and violet.

Iron exhibits a bright orange, four faint green, and sometimes two faint blue bands.

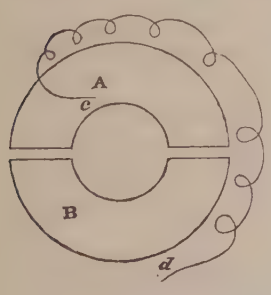
Bismuth a bright orange, a very faint yellow, two faint green, and a bright indigo.

Antimony some bright orange, and faint appearances in the yellow, geen, and blue.

Brass, a compound of copper and zinc, exhibits all the bands that are exhibited by these metals separately, *i. e.*, one of red, one of orange, three of green, three of blue, one yellow, and one indigo.

The preceding table presents these results, with some faint bands not above alluded to.

To illustrate better the manner of producing sparks by the magneto-electric machine, I have annexed the following figure of the break. A and B represent two half circular disks of the metal intended to be used. One of these is connected with one end of the helix, and the other with the other end. They are fixed on the spindle of the revolving armature, and revolve with it. They are so placed that the extremity *c* of the wire *c d*—which is stationary and rubs on them—is passed from the one to the other at the same time that the armature is passing the poles of the magnets.



In order to produce sparks, the end *d* of the wire is caused to rub on the disks, nearly opposite C—which causes a bright spark at each half revolution of the armature.

When the disks are of zinc, and the extremity *d* of the wire is of copper, the bands are the same as in brass, as also if the disks are of copper, and the wire zinc. When the disks and wire are both of copper, after having used a wire of zinc on the disks—they will still exhibit the same colored bands as the brass until all the zinc left by the friction is removed, when the characteristic bands of the copper alone appear.

When silver and copper are used the bands are the same as with the silver alone, with the addition of two bands in the green, and so with any two metals, the bands are the same that both the metals exhibit when used separately, and the number of bands in the two metals will be equal to the number in both, except where they have bands that correspond in situation, in which case the bands of the two metals are blended together, producing bands of great brilliancy. A spark between charcoal points does not show any peculiarity. The orange band appears to be common to all the metals tried—but I have not determined whether it occupies the same situation in the spectrum in all cases. The light of the spectrum not collected into the several bands, differs in intensity with the different metals—that with tin, iron, and antimony being strong, while that of silver, copper, and zinc is faint.

On certain Physical Properties of the Light of the Electric Spark within certain Gases as seen through a Prism.

by D. Alter, M.D., of Freeport, Pa.*

In a former communication, I noticed the peculiar character of the light produced by interrupting the galvanic circuit, between different kinds of metal. I also mentioned that several bright bands were observed in the common electric spark. I have since employed various metallic conductors, but without producing the bands corresponding with those resulting from the interrupted galvanic circuit between the same metals—the bands always remaining the same, whatever metal was employed. It then occurred to me, that the bands were characteristic, not of the metals, but of the atmosphere through which the sparks passed. To test this view, I passed the spark through various gases, in succession, and found that they were characterized by their appropriate bands, with as much distinctness as the metals are by the galvanic spark; *e. g.*, I discovered in atmospheric air, one red, one orange, two green, one blue, and one indigo; while in hydrogen, I discovered one very bright red, two faint green bands, and one very faint blue. In nitrogen, one red, one orange, and two green. In chlorine, two distinct green bands, and a knot of light in the yellow and also in the blue, which I think are composed of several bands close together in each. In carbonic acid, there are, one red, three orange, and two green bands. In sulphuretted hydrogen, there are red, orange, and green bands. In oxygen, no bands were discovered, but the light was strong throughout the spectrum. In the other gases it is feeble, except in the bands before mentioned. The quantity of light in the red band of the spark, in hydrogen, is quite remarkable, being so great, that the spark, seen without the prism,

* Am. J. Sci., xix., 185., p. 213.

has a very red appearance, as also in the gases compounded of hydrogen. From this, we perceive the cause of the difference in color, in the flashes of lightning—for when the electricity has a watery conductor, in much of its course, it will emit red light, but when it passes through air, the light will be white; as, in the spark through that medium, the bands are well distributed among the colors of the spectrum. The colors also, observed in the aurora borealis, probably indicate the elements involved in that phenomenon. The prism may also detect the elements in shooting stars, or luminous meteors.

Since, from the preceding observations, it is evident that the electric light, whether from the interrupted galvanic current or from the common electric machine, is principally resolved into several bright bands by the prism; and that the light, thus produced by one elementary body, differs in the number, brilliancy, and situation of its bands, from every other element, so that it is immediately recognized, by mere inspection—we are led to the following inquiries. Is there such a *fluid* as electricity? or, are the phenomena, commonly reputed electrical, the result (as suggested by Prof. Graham) of chemical affinity? If so, are there only two poles, a chlorous and a zincous, to each molecule—c^n, are there as many poles or combining surfaces as are indicated by the number of bright bands of its refracted light? And (if the undulatory theory of light may be depended on) would not these bands give an indication of the size of those surfaces or poles?

On Daguerreotying the dark lines in the Solar Spectrum.—Being desirous to know whether corresponding lines exist in the actinic rays, I adopted the following method. The sun's rays were admitted into a dark chamber, between the edges of two pieces of sheet brass about eight inches in length and separated about the thirtieth of an inch, at one end, but in contact at the other.

Near the outside of the aperture thus formed, was placed a large lens, five feet in focus. Near the focus of the lens in the chamber, the rays pass through a prism and through a second lens of about 20 inch focus, which shows the dark lines very distinctly on white paper, at its focus, for rays coming from the slit. The prepared daguerreotype plate, placed in the focus and exposed for one or two seconds, produces the effect.

In the daguerreotype which I send you, there are two spectra caused by filing the brass slips so as to cause an aperture one side of the point of contact. I have placed the letters on the lines as given in Brewster's Optics, 1837, page 79. They would correspond with Prof. Draper (see this Journal, March, 1848) if the H occupied the place of I.

I could not see the spectrum further than the breadth of the second broad line at I in the direction beyond that line, when looking through the prism and slit at the sun. But by receiving the spectrum on paper stained with alcoholic tincture of turmeric, several dark lines can be seen beyond these and the blue appears to be changed to violet down to the line F.

MILK, ITS SUPPLY AND ADULTERATION.

BY DR. VOELCKER.

Milk may be regarded as a kind of model food. It supplies all the various elements of nutrition which are required to build up the bony frame and muscular tissue of the young, and, at the same time, supplies materials for the support of respiration and keeping up the animal heat of the body. Undiluted with water, milk is both a readily digestible and valuable, if not indispensable, article of food for children. Breeders of high-priced shorthorns know full well how essential it is to the early development of a sound and strong frame, round which the flesh and fat may be afterwards deposited in symmetrical forms, not to stint the calf in milk; and it is to be feared that the children of the artisan and the poor in towns and of the agricultural laborer in the country, frequently are not nearly so well supplied with milk, both as regards quantity and quality, as the progeny of a well-cared-for herd of shorthorns, or Ayrshire or Devon cows. If it be remembered that the bodily health of the adult is affected in no small degree by the amount and quality of the food with which the infant, from the time of its birth and throughout the period of childhood, is fed, and also that much physical suffering might be prevented if children were not stinted in a milk diet, it is doubly desirable that the scanty allowance of milk in which the children of the poor are generally indulged should be unadulterated and of the best quality that can be procured. We hail, therefore, with pleasure the enforcement of the Food Adulteration Act, for there can be no question that before the Act came into practical operation, the milk sold alike to rich and poor in London and other large towns was watered much more generally, and to a greater extent, than it is at present in places where public analysts keep a watch over the milkman. Every honest dealer in milk entertains the same feeling with regard to the intentions of this Act, and the measure of success with which it has been carried into practice; for it cannot be to the interest of the upright dealer to have to meet the competition of the unprincipled retailer who waters his milk in the barefaced manner so prevalent in London and other towns a few years ago. The honest dealer has nothing to fear from having the milk which he supplies examined; and a wholesome check upon milk adulteration is put by the infliction of a penalty, still more by the publicity which is given to cases in which persons have been convicted of having sold adulterated milk. Nevertheless, the Food Adulteration Act requires to be carefully scrutinized, and to be revised in not a few of its details, if it is not to defeat, in a great measure, the very object for which it was passed. In carrying out legislative measures of the nature of the Food Adulteration Act, great care should be taken to make provisions which shall render it impossible to inflict undeserved injury upon the honest trader. Unfortunately, purveyors of milk, in not a few instances, are placed at the mercy of men whose want of practical knowledge of the various circumstances which affect the quality of milk is well matched by their inexperience and want of skill in conducting chemical operations. Numerous recent trials afford convincing proofs of the fact that the presiding magistrate at times knows as little about milk as a new-born babe, and that the greater the ignorance of the analyst, the more positive he is generally in making wanton statements. No wonder, then, that the honest dealer is alarmed by the reckless operations of medical inspectors and the reports of food analysts, in consequence of which, occasionally, the innocent has to share the fate of the guilty. It is somewhat surprising that nothing has been done as yet, either by the dairy-farmers in the country or by the proprietors of town dairies, or by the milk trade generally, to expose the arbitrary decisions which have been given in milk prosecutions during the last twelve months on the strength of analytical reports

which bear internal evidence of gross ignorance of a practical acquaintance with milk and its chemical constitution. I shall have to enter more fully upon the subject of milk adulteration, and find opportunity to show that several of the assertions which have been made by milk analysts are based on gross ignorance, and that in the interest of the fair and upright dealers, no less than in the interest of the consumer, it is desirable at once to relieve analysts who display such a degree of practical unacquaintance from their functions of food analysts. With regard to the supply of milk, we have to consider—(1), the country supply; (2), the town produce; (3), the supply of preserved or condensed milk. The question frequently asked is, Should milk be supplied exclusively from the country, or may it not be supplied equally well from town-fed cows? Another question is, Is country milk better than town produce, or *vice versa?* And a third question is, What is the best food for milk-cows?

1. *Country Milk.*—Cows kept on nutritious grass and hay, and abundantly and exclusively supplied therewith, as a rule produce richer milk and of a finer flavor than town-fed cows. An example of such extremely rich country milk, brought under my notice, produced from cows kept on very good pasture land, contained in 100 parts—

Water	83·90
Fatty matters (pure butter)	7·62
Caseine (curd)	3·31
Milk-sugar	4·46
Mineral matter (ash)	·71
	100·00
Percentage of solid matters	16·10

Such rich country milk, however, seldom finds its way into the hands of milk dealers, nor does milk from cows fed exclusively upon grass often contain as much as 7½ per cent. of pure butter. On the contrary, if pastures are overstocked, and the herbage is naturally poor, and the food supply in consequence is insufficient to keep cows in a thriving condition, the deficiency of food tells immediately both upon the quantity and the quality of the milk. A striking instance in point came under my notice when I resided at the Royal Agricultural College, Cirencester. The cows (16 or 18) were out in September on grass, but the pasture was poor and overstocked, and hardly enough grass was grown to meet the demand for restoring the daily waste to which the animal body is subject, and the supply of food consequently was ill adapted to meet an extra demand of materials for the formation of milk. Under these circumstances, I found both the morning and evening's milk very poor, as the following analyses made with average samples from the milk of all the cows will show:—

	Morning.	Evening.
Water	89·95	90.70
Fat (pure butter)	1·99	1·79
Caseine (curd)	2·94	2·81
Milk-sugar	4·48	4·04
Mineral matter (ash)	·64	·66
	100·00	100·00
Solid constituents	10·05	9·30

Here we have two practical illustrations showing how largely the quality of the milk is affected by the amount and richness of the natural pasture upon which the cows are kept. In the case of the cows kept in the rich pastures the milk contained, in round numbers, 7½ per cent. of butter; whilst the badly-fed cows, also out on grass, gave milk so poor as to yield in one instance barely 2 per cent., and in the other about 1¾ per cent. of butter. My analyses were not made with the milk-produce from a single cow, but with a fair average sample of the whole produce from some 16 or 18 cows which were milked in my presence. It thus appears that country milk may be either very rich or be very poor. Speaking generally, country milk from cows out on rather poor and overstocked pastures is poor, and compares very unfavorably with the milk from town-fed cows. According to careful records, 245,458 gallons of milk were produced in seven years by a herd, averaging 65 cows (shorthorns), or 535 gallons were produced by each cow per annum, the food being grass and hay, with roots and straw in winter. Putting 530 gallons of milk against 28 tons of this green food, we have 1 lb. of milk to every 11 or 12 lbs. of grass, or, as nearly as possible, 100 gallons of milk to every ton of hay. If the object of the dairy-farmer is to produce milk for the town, it will not pay him to keep grazing dairy-stock on growing grass, and he will find it to his advantage to feed the cows in houses upon cut grass, supplemented by oil-cake meal, brewers' grains, and similar purchased food. As a matter of economy, milk can be produced as economically in or close to large towns as in the country, for any extra expense to which a town dairy-farmer may be put is made good by the expense of carriage to the nearest railway station, and the railway charges. The advocates for the town produce of milk maintain that in warm weather a good deal of milk is spoiled during its transmission by railway. However, by observing the following simple rules, country milk may be sent by rail on long journeys without spoiling even in very hot weather. 1. The milk should be drawn from the cow in the most cleanly manner, and strained through wire-cloth strainers. 2. The milk should be thoroughly cooled immediately after it is drawn from the cow. This may be done by a milk cooling apparatus, specially constructed for rapidly cooling milk, or by simply placing the can in which it is contained, in a vat of cold water, deep enough to come up to the height of the milk in the can containing it, and by using at least three times as much cold water as the milk to be cooled; the milk should be occasionally stirred until the animal heat is expelled. The milk should be cooled down as rapidly as possible to a temperature of about 55°. 3. The evening's and morning's milk should be cooled down separately, and be sent in separate cans, and not mixed together if it can be avoided. 4. No milk should be kept over to deliver at a subsequent time. 5. The pails and strainers employed on the farm should be thoroughly cleaned, scalded in boiling water, and dried morning and night. 6. Immediately before the milk is placed in the cans, they should be thoroughly rinsed with clean cold water, and great care be taken to keep the cans and milk free from dirt or impurities of any kind. When the cans are not in use they should be turned down on a rack, with the tops off. 7. Before the cans are returned to the country they should be thoroughly rinsed out with clean water and scalded with boiling water. 8. In very warm weather, it is well to put the milk cooled in cans covered over with a coarse flannel casing, which may be kept wet for a considerable time.

2. *Town Produce.*—As regards the quality of milk

from town-fed cows, I would observe that I have had a very large experience in the examination, both of country and town-milk, and am bound to say that, as a rule, London milk, when undiluted, is considerably richer in cream than country milk. I ascribe this to the fact that cow-keepers in large towns mostly are men of business, who find it profitable not to stint their cows in food, and to supply them with a better and richer description of food than that which the ordinary run of dairy farmers provide for theirs.

3. *Preserved and Desiccated Milk.*—When milk is evaporated at a low temperature, and a little sugar is added when the process of evaporation is nearly completed, the residue which is left on final evaporation on being reduced to powder constitutes a white powder with a yellow tinge, which dissolves for the greater part in boiling water. The solution resembles in appearance and taste milk, and answers pretty well as a substitute for milk for ship's use, or when fresh milk cannot be obtained. Desiccated milk, if well prepared and perfectly dried, may be kept in closed bottles for many months without undergoing any change, but it does not dissolve perfectly in water, and is deficient in the agreeable taste which characterizes good fresh milk. Usually a portion of the cream is removed before the evaporation of the milk; for if the whole milk is condensed by slow evaporation, the desiccated milk is very apt to assume, after a short time, a bad taste resembling rancid butter. The following are analyses which I made some time ago of two samples of desiccated milk:—

	No. 1.	No. 2.
Moisture	4.09	1·78
Fat (pure butter)	8·73	16·32
Caseine	20·25	20·37
(containing nitrogen)	(3·24)	(3.26)
Phosphate of lime and magnesia	2·34	2·33
Alkaline salts	2·48	2·91
(containing phosphoric acid)	(0·26)	(0·31)
Sugar	62·14	56·29
	100·00	100·00

The second sample, it will be seen, contains nearly twice as much fat (pure butter) as the first, which was evidently produced from skim-milk. The sample No. 1 had a nice taste, and, notwithstanding the deficiency of butter, was a superior preparation in comparison with the second sample, which had a disagreeable taste of rancid butter. A much better description of concentrated milk has been prepared for a good many years past in America, under Borden's patent, and a few years since an American Company—the Anglo-Swiss Condensed Milk Company—has established a factory at Cham, near Zug, in Switzerland, for the production of pure Swiss preserved milk. This company, with a capital of £12,000, employs about sixty operatives in the factory. The number of cows hired for the year is 1440, and the average amount of condensed milk prepared daily during each of the 365 days of the year is 110 cases, of four dozen each of 1 lb. cans; these equal 1,927,200 cans as the product of the year. The price of the crude milk is about 2*d.* per quart; and the daily cost of the tins or cans made at this establishment amounts to £16 10*s.* About one-half of the product is sent direct to London, where one-half is consumed, while the remainder goes for ships' stores, is exported to the colonies, and sent to the provincial towns of England. One-half of the produce not sent to London is distributed over Germany, and there is some demand from France and Russia. The milk is evaporated down *in vacuo* at a uniform temperature of 160 deg. Fahr., with the addition of the best refined white sugar, until it reaches the consistency of thick syrup or honey. It takes about seven hours to condense the milk, 75 per cent. of its original bulk in water being driven off. The condensed milk thus prepared has been preserved in good condition for years. Mixed with three to four pints of water it readily dissolves, yielding a somewhat sweet but agreeably tasting fluid, having a flavor of boiled milk. It consists of nothing but cows' milk and the best white sugar, and is well adapted for use during long voyages and in all other situations where good cows' milk is not readily procurable. A sample of preserved milk prepared by the Anglo-Swiss Company on analysis yielded the following results in my laboratory:—

Water	24·89
Fat (pure butter)	8·36
Caseine (curd)	10·15
(containing nitrogen)	(1·624)
Milk and cane-sugar	54·18
Mineral matter (ash)	2·42
	100·00

About one-half of the solid substances of the condensed milk consists of sugar added in the process of condensation. The remainder consists of butter, caseine, milk sugar, and ash constituents. It is but right to state that the analyses of other samples of preserved milk prepared by the Anglo-Swiss Company show about ten per cent. of butter and somewhat less water than I found in the sample analyzed by me. Those who take a special interest in the manufacture of condensed milk will find a full account in a highly interesting paper, illustrated by many wood-cuts giving a full description of the necessary apparatus and the processes of manipulation, by Mr. X. A. Willard, of Herkimer, New York, published in vol. xv., new series, part 1, 1872, of the Journal of the Royal Agricultural Society of England. The success of the Anglo-Swiss Company naturally created competition. Condensed milk factories were established at Gruyères and half-a-dozen other places in Switzerland, in Bavaria, in Holstein, in Ireland, and in England; but failing to produce first-quality preserved milk, and wanting in prestige and other causes, they have ceased to manufacture, with the exception of Mr. Newman's Irish condensed milk factory at Mallow, near Cork, and the English Condensed Milk Company, whose works are at Aylesbury, Buckinghamshire.

Food appropriate for producing much and good Milk.—The influence of food on the quality of milk is very striking. A half-starved cow yields but little milk and poor milk. On the other hand, the liberal supply of peas or bean-meal, or oil-cake, and other food rich in nitrogenous and phosphatic elements of nutrition, tells directly, both on the quality and quantity of the milk. The finest flavored milk and butter are produced by cows fed in summer entirely on grass and rich permanent pastures, and in winter on nothing else but hay, made of fine sweet grass. Turnips yield a watery milk, and are objectionable, on account of the turnipy flavor which they give to the milk. Mangolds are less objectionable, but should not be given to milk-cows without an allowance of 3 to 4 lbs. of meal per head. Of all kinds of meal, none is equal in milk producing properties to bean or pea-meal—a fact which finds a ready explanation in the circumstance that bean or pea-meal contains on an average from 25 to 28 per

cent. of nitrogenous constituents, or the same class of compounds to which the curd of milk belongs, and that it is likewise rich in phosphates or bone earths, in which milk abounds. Egyptian lentils answer equally well with bean-meal, for they resemble intimately in composition beans or peas. Linseed-cake produces much and rich milk, but unless it is pure and fresh cake of the finest description, it seriously injures the quality of the milk. Fine decorticated cotton-cake is both rich in fat and in nitrogenous constituents, and like all food rich in nitrogen it also contains a large proportion of phosphates, and is thus admirably well adapted for milk-cows. Rape-cake is likewise an excellent food for milk-cows, provided it is free from an undue admixture of wild-mustard seed, which frequently occurs in rape-cake made from Indian seed to an extent which renders it perilous to stock. The best rape-cake is green German rape or Rubsen cake, one of the cheapest and best concentrated kinds of food that can be given to milk-cows. Bran or pollard, as is well known, produces good and rich milk. Nothing can be better as an auxiliary winter food for milk-cows than 4 lb. of bran made into a thin mash, to which about 3 to 4 lb. of bean-meal is added. Along with this about 25 lb. of mangolds, and a due proportion of hay or hay and straw chaff will supply a food-mixture which produces much and first-quality milk. Brewers' grains are the staple food in town-dairies, and they are much more nutritious than their appearance seems to warrant. Even in the wet condition in which they are obtained from the breweries, and holding from 75 to 77 per cent. of water, they contain a fair proportion of ready-made fat and flesh forming matters. Desiccated grains contain from 7 to 8 per cent. of oil, and about 18 per cent. of nitrogenous compounds. Dried brewers' grains make good milk, and are fully as valuable as a food for milk-cows as barley-meal. Another useful and, comparatively speaking, cheap food for milk-cows is palm-nut meal, but its quality and value differ greatly. The best palm-nut meal contains 19 to 20 per cent. of oil and fat, and is made from the partially-expressed kernels of the palm-nut; its value as a food for fattening stock or for milk-cows depends principally upon the proportion of fatty matter which is left in the meal. The fatty matter in palm kernels is a white, agreeably tasting fat, of almost the same consistency as butter.

A good deal has been said and written for and against feeding milk-cows upon sewage grass. On the one hand, sewage-grass has been praised as the most nutritious kind of grass for milk-cows; and, on the other, the adversaries to all schemes of applying sewage to land have endeavored to prejudice the public mind by denouncing the produce from grass land irrigated by sewage as innutritious and a highly dangerous food for milk-cows. Like all very succulent produce, the grass from sewaged land is more watery, and, in consequence, not so nutritious as the produce from rich permanent pastures. It is, nevertheless, a most acceptable food to the dairy-farmer, who usually gives along with it to his cows some bean or other descriptions of meal or auxiliary concentrated food, and, under proper management, there is not the slightest ground for suspecting that sewage-grass when given to milk-cows will render the milk they yield unwholesome or dangerous to the youngest child. If sewage could not be usefully applied to Italian rye-grass to be turned into milk and butcher's meat, all sewage-irrigation schemes would long ago have fallen to the ground. Convinced as I am that the produce from a properly managed sewage-farm supplies an increased amount of good and wholesome food, the greater part of which is especially useful to cowkeepers, I can only express the hope that all town authorities, who at present allow large quantities of plant-food to run to waste, polluting our rivers and watercourses, will ere long set apart a portion of land, if such can be found appropriate for sewage irrigation, on which Italian rye-grass, cabbages, and mangolds can be raised in large quantities by means of sewage, for the special advantage of cowkeepers, and the benefit of the community at large.

Milk Adulteration.—Milk is a whitish liquid of an agreeable, sweetish taste, and faint but pleasant odor, depending in some measure upon the nature of the food upon which the cows are fed. It is essentially an emulsion of fatty particles in a solution of caseine and sugar of milk. The fatty matter is not contained in milk in a free state, but inclosed in little cells of caseine, which occurs also in milk in a state of solution, and is precipitated spontaneously as curd when milk gets sour. Viewed under the microscope, milk appears as a transparent fluid, full of small, round, or oval, and more or less angular bodies—the so-called milk globules. When milk is left undisturbed for some time, these milk globules rise to the surface, forming the cream of milk. Skim-milk has a bluer color, and is more transparent than new milk containing its full share of milk globules or cream or butter globules. The amount and quality of the food given to cows exercise a most remarkable influence on the quality and composition of milk. Besides this, the season of the year, distance from the time of calving, the breed and size of the cows, and several other circumstances which will suggest themselves to practical men, have a greater or less influence on the yield of milk and its quality. When residing at Cirencester College, with a view of acertaining what may be the variations in the course of a year in the quality of milk on one and the same farm, I took samples of the milkings of all our milk-cows, and analyzed the morning's and evening's milk of the first or second day of each month. The milk-cows were out at grass from May till the end of October, and as the herbage then became so scarce as not to afford sufficient nourishment, they were fed in the evening at the stall on roots and hay, etc. It will be seen by the appended analyses that both the morning's and evening's milk in September were extremely poor. The poverty of this milk was therefore evidently due to an insufficient supply of food. The milk produced on two other farms in the neighborhood during the same month, on being analyzed, was found to contain 12½ per cent. of solid matter, including 3½ per cent. of fat (pure butter), and the same percentage of curd; showing that on both farms where the cows were supplied with a sufficient amount of nutritious food, the milk was of good quality, whereas on the College farm the scanty supply of poor grass had the effect of producing poor milk, containing 90 per cent. of water, and only 2 per cent. of fat. The influence of food on the quality of milk was also clearly visible in the cows of the College farm. On account of the insufficiency of the grass, the cows were driven into the stall and there supplied with roots, hay, and meal. The milk became better at once, for the morning's yield then contained 12½ per cent. of solid matter, and in this nearly 4 per cent. of butter. The concentrated food which the cows received in the evening was evidently made into good rich milk during the night. At this time the cows were put on grass early in the morning and allowed to pick up what they could. This was not

much, as their anxiety in the evening to be let into their stalls clearly showed. The influence of a stinted supply of grass was noticed at once in the poverty of the evening's milk. The percentage of solid matter fell to 9⅔ instead of 12½ per cent., and the butter to 3 instead of 4 per cent. I would direct especial attention to the fact that these analyses were not made with milk of a single cow, but that of the whole herd, and as the milk cows were kept entirely for the use of the College, there can be no question as to the genuineness of the supply.

Composition of Morning's and Evening's Milk produced on the Royal Agricultural College Farm, Cirencester.

		Percentage of					
		Water.	Butter (pure fat).	Caseine and Albumen.	Milk-Sugar.	Mineral Matters (ash).	Nitrogen.
January.....	Morning	87·70	2·60	2·94	5·82	·94	·47
	Evening	87·40	2·28	2·87	6·56	·89	·46
February.....	Morning	87·50	2·58	3·44	5·44	1·04	·55
	Evening	86·40	3·53	3·37	5·56	1·14	·54
March.....	Morning	88·60	2·71	2·43	5·35	·91	·39
	Evening	88·16	2·96	2 62	5·55	·77	·42
April.....	Morning	87·50	3·15	2·94	5·60	·81	·47
	Evening	89·00	2·47	2·69	5·08	·76	·43
May.....	Morning	88·20	2·42	3·12	5·49	·77	·50
	Evening	87·80	2·71	2·87	5·85	·77	·46
June.....	Morning	87·30	3·05	3·00	5·89	·76	·48
	Evening	87·30	2·94	2·87	6·05	·84	·46
July.....	Morning	88·70	2·22	2·94	5·38	·76	·47
	Evening	87·80	3·61	2·81	5·10	·68	·45
September....	Morning	89·91	1·99	2·94	4·48	·64	·47
	Evening	90·70	1·79	2·81	4·04	·66	·45
October.....	Morning	87·60	3·90	2·87	4·84	·79	·47
	Evening	90 30	2·99	2·37	3·76	·58	·38
November....	Morning	87·10	3·41	2·94	5·41	1·14	·47
	Evening	86·20	3·78	3·19	5·68	1·15	·51
December....	Morning	86 70	3·74	2·87	5·92	·77	·46
	Evening	86·00	4·12	3·62	5·46	·80	·58

I have alluded specially to these variations in the quality of milk as influenced by food, because some statements have lately appeared in a little work on milk analysis written for the special benefit and instruction of food-analysts, "a new class of men," which has lately been "constituted to watch over the food of the country." I leave it to you to form your own opinions from the following extracts taken from this treatise. According to the author, country milk of average quality contains in 100 parts by weight—

Water	87·55
Fat	3·08
Caseine	4·04
Milk sugar	4·62
Ash	·71
	100·00

Town-fed milk, according to his analysis, contains in 100 parts by weight—

Water	85·94
Fat	4·00
Caseine	5·02
Milk-sugar	4·31
Ash	·73
	100·00

It will be seen that the latter milk shows a difference of one-third more of fat and one-quarter more than the amount of caseine contained in the former, and a corresponding smaller amount of water. These differences are sufficiently striking to show, at all events, that milk has not a uniform composition. Nevertheless, our author says, "Milk exhibits great constancy of composition; the effect of variations in the diet of the cow showing itself in the amount of the secretion, rather than in its quality:" and again, "As will be readily comprehended, this constancy of composition is a cardinal fact in milk analysis. If milk were variable in strength, as urine is, chemical analysis would fail to detect the watering of milk. That milk is a secretion of constant, or only slightly varying composition, lies at the very root of the subject of this treatise." In the face of the evident contradictions between the facts given and the opinions expressed by this same author, I think I need not detain you by criticizing other portions of the treatise, but leave you to draw your own conclusions as to the value of the frequent use he makes of what he calls "normal milk." One might as well talk of a "normal potato," or a "normal cabbage," or a "normal pig." On passing along on the top of an omnibus a short time ago, I was somewhat amused at seeing an advertisement of a wine merchant of his "standard sherry," and I am surprised that standard or "normal" milk is not advertised, as it might be with quite as much reason as "standard sherry." A great deal has been said and written about milk adulteration. Sheep's brains, starch, chalk, and pipe-clay are said—on what authority nobody has ever decided—to have been found in milk; but the basis for these statements exists only in the imagination of credulous or half-informed scientific men, who, in want of more profitable occupation, take to book-writing. It would be difficult to understand where all the sheep's brains should come from; nor is it probable that chalk or other insoluble substances not easily kept in suspension, should be employed in adulterating milk. I have never found myself, nor have I ever met any chemist who has found, any of the clumsy adulterations often referred to in popular treatises on food. Milk adulteration resolves itself into one of two things—either the addition of water, or the abstraction of cream; and the question which naturally arises is, Can we detect to a nicety how much water has been added or how much cream has been abstracted from a given simple? I have, perhaps, had as much experience in the examination of milk as anybody in England, and I fearlessly say that, owing to the natural variations in milk, it is utterly impossible in all cases to ascertain whether a small quantity of cream has been removed from milk, or an inconsiderable proportion of water has been added to it; and I further maintain that it is a reckless proceeding on the part of any analyst to assert that milk has been adulterated with exactly 8 per cent. of water, or with 13·75 per cent. of skimmed milk, as in one case, or with 16·25 per cent., as in another. Such assertions can only be made by young and inexperienced men, for whose special instruction such milk treatises as I have above referred to are compiled. No wonder that men who entertain such inconsistent views of "normal milk" should be led to give reports in which they positively assert that they have found 16·25 per cent. of skimmed milk, because the amount of fat did not come up to their standard by a few decimals. I may state, in passing, that in a recent case the milkman, who was accused of selling milk adulterated with 16·25 per cent. of skimmed milk, was fined in the "mitigated penalty of £5." with the alternative of ten days in jail. In the course of the trial testimony was given by a worthy

town councillor, who had carried on business as a temperance hotel-keeper, that the accused had been known to him for the last twenty years, and had during the whole of that time supplied him with milk. He further expressed his opinion that no better milk was to be obtained than that of the accused, against whom he had never known any complaint. A well-known chemist, moreover, was called for the defence, and, on the strength of the analysis, he pronounced the milk to be of the quality of good ordinary country milk, quoting, in support of his opinion, no less an authority than the late Professor Johnston, but apparently to no purpose, because the amount of fat contained in the milk differed in a trifling extent from what the food analyst conceived to be the amount contained in "normal milk." A medical man, called in support of the prosecution, gravely stated that milk containing 16·25 per cent. of skimmed milk would be prejudicial to the health of the very young, although its effects would be hardly appreciable on an adult. Instances of this kind would be very ludicrous but for the serious consequences involved, and the injustice which, no doubt, is frequently dealt to honest dealers. Let it, however, be clearly understood that I have no intention of throwing cold water upon the system of chemically examining milk. All I desire to show by these observations is, that milk analyses should be conducted by men upon whose practical experience and acquaintance with the subject reliance can be placed. Chemical analysis can do much in the way of revealing adulteration of food, and there is no difficulty in discovering whether milk has been skimmed or watered to any great extent. As the result of my own experience, I may state that milk may be considered rich when it contains from 12 to 12½ per cent. of solid matters, 3 or 3½ of which are pure butter. If it contains more than 12½ per cent. of solid matter, and has 4 per cent. or more of fat, it is of extra rich quality. Such milk usually throws up from 11 to 12 per cent. of cream (by bulk) after standing for 12 hours at 62 degrees Fah., and it has a specific gravity varying from 1·028 to 1·030. Good milk of fair average quality, as has been stated already, contains from 10½ to 11 per cent. of dry matter, including about 2½ per cent. of pure fat. It yields 9 to 10 per cent. of cream, and has a specific gravity of about 1·030. Poor milk contains 90 per cent. or more water, and has a lower specific gravity than 1·027. Such milk does not yield more than 6 to 8 per cent. of cream. Skimmed milk throws up still less cream, has a bluer color, and is more transparent, and when undiluted with water has a slightly higher specific gravity than new milk. Good skimmed milk has a specific gravity of about 1·033, and poor skimmed milk 1·028 to 1·030. Milk purposely watered yields only 5 to 6 per cent. of cream, and invariably has a lower specific gravity than 1·025. If milk is both skimmed and watered, it yields less than 4 per cent. of cream, and possesses as low a specific gravity as 1·025 to 1·026. A great many experiments have led me to the conclusion that within certain limits the specific gravity is the most trustworthy indicator of quality. Some of the objections to the use of hydrometers or instruments for taking with accuracy the specific gravity of milk, are based on the mistaken opinion that cream is lighter than water. This, however, I have ascertained is not the case. Cream, I find, is lighter than milk, but denser than water, in the proportions of 1012, or even 1019 to 1000. The addition of cream, therefore, cannot depress the specific gravity of milk in the same degree as the addition of water. A low specific gravity thus always indicates a large proportion of water; at all events, I find that milk rich in butter is of a specific gravity a good deal higher than milk adulterated with even a little water. Some years ago I made some accurate gravity determinations of pure milk before and after skimming, and of samples mixed purposely with 10 to 50 per cent. of water.

	Sp. gr at 62° Fahr. Before skimming.	Sp. gr. at 62°. Fahr. After skimming.
Pure milk	1·0314	1·0337
With 10 per cent. water	1·0295	1·0308
With 20 per cent. water	1·0257	1·0265
With 30 per cent. water	1·0233	1·0248
With 40 per cent. water	1·0190	1·0208
With 50 per cent. water	1·0163	1·0175

It appears from these results that good, pure milk has a specific gravity of 1·030; skimmed milk being a little higher; and, further, that milk, having a specific gravity as low as 1·025, is either mixed with water or is naturally very poor. If the gravity should sink to 1·023 or less, it is unmistakably mixed with a considerable quantity of water. A useful instrument for approximately determining the percentage of cream is a graduated glass tube, at the top of which the cream may be allowed to collect, and its quantity may be read off. There can be no doubt about the fact that, before the late Adulteration Act, the milk of London was shockingly adulterated, and it was high time that a check should be placed upon the malpractices of milk-dealers. I am, however, anxious that the Act should not become ridiculous in the eyes of a discriminating public, for several recent milk-prosecutions have shown that the wisdom of the wise (food analysts) in more than one or two instances is truly foolishness, even in the sight of any ordinary dairyman. I should advise rigorous prosecution in every case of flagrant or unmistakable adulteration; but whilst those entrusted with the enforcement of the Act draw the line so finely as they too frequently do at present, between pure milk and that which has been tampered with, serious mistakes must and will necessarily arise, to the discredit of all concerned in the matter, and sometimes, perhaps, to the irrecoverable loss of the reputation of an innocent man.—*Pharm. Journ. and Trans.*

ANALYSES OF EWE AND GOAT MILK.

BY DR. STEVENSON MACADAM, F.R.S.E.

At the annual general meeting of the Gala Water Farmers' Club, held in the Town Hall, Stow, on Friday, May 1st, Dr. Stevenson Macadam gave an address on "Chemistry in connection with Agriculture," in the course of which he made the following remarks on the composition of ewe and goat milk:—

The nourishing properties of the various natural and artificial feeding stuffs must not only have an important bearing upon the sustenance, growth, and fattening of stock, but also on the quality of milk yielded by cattle and sheep grazing on different pastures, and feeding on various artificial materials. Every agriculturalist knows that there are certain fields where the sheep and lambs thrive better than on other fields; and such difference in the respective sustaining powers of the fields must be ascribed, in great part at least, to the respective qualities of the pastures in these fields—directly available in the grass, and indirectly available in the milk. Through the kind co-operation of my friend, Mr. Lyall, of Caddonlee,

I have been able to obtain five samples of ewe milk taken direct from the udders of five ewes placed under somewhat different circumstances; and having analyzed these samples, I have now the opportunity of giving you the detailed results. I may mention that No. 1 ewe was newly lambed, and had been fed on turnips and second year's grass; No. 2 ewe was fed on second year's grass; No. 3 ewe was on first year's grass; No. 4 ewe was also on first year's grass, but in a different field; and No. 5 ewe was feeding on old pasture, probably 100 years old. Nos. 2, 3, 4, and 5 had been lambed for two to three weeks. The following table gives the principal results of the analyses of these samples of milk:—

ANALYSES OF EWES' MILK.

No. of ewe.	Specific gravity of milk.	Cream per ct. by volume.	Total solids per cent. by weight.	Solids not fat, per cent. by weight.	Fat in solids per cent. by weight.	Ash in solids per cent. by weight.
1. Time of lambing.....	1032·0	30	25·14	13·52	11.62	0·96
2. Two to three weeks lambed.....	1043·9	11	16·83	13·29	3·54	0·92
3. do. do.....	1036·2	20	19 83	12·41	7·42	0·98
4. do. do.....	1038·5	12	15·91	12·04	3·87	0·91
5. do. do.....	1027·9	22	18·55	10·48	8·07	0·94
Mean of all trials.....	1035·7	19	19·25	12·35	6 90	0 94
Mean of milk from Nos. 2, 3, 4, and 5 ewes, and excluding No. 1 ewe, being newly lambed	1036·6	16	17·78	12·06	5·72	0·94

It will thus be observed that the ewe milk taken at the time of lambing was extremely rich in solids and fat, and the milk taken from two to three weeks old varied much in quality. Indeed, excluding No 1 ewe milk, which, being at the time of lambing, must be regarded as exceptionally high, the other samples of ewe milk ranged in specific gravity from 1027·9 to 1043·9; cream, from 11 to 22 per cent.; total solids, from 15·91 to 19·83 per cent.; solids not fat, from 10·48 to 13·29 per cent.; fat in solids, from 3·54 to 8·07 per cent.; and ash in solids, from 0·91 to 0·98 per cent.; whilst the average of the milks from Nos. 2, 3, 4, and 5 ewes, gave specific gravity 1036·6; cream, 16 per cent.; total solids, 17·78; solids not fat, 12·06; fat, 5·72; and ash, 0·94. I am quite aware that the milk of a single ewe taken from each field must not be held as representing exactly the relative average composition of the milk from the whole or even from a score of the sheep in the respective fields; but taking the results of the analyses of the milks yielded by the ewes at Caddonlee, there can be no doubt that the milk of one ewe differs in quality, and probably also in quantity, from the milk of other ewes grazing on the same farm and even in the same field. (Immediately after the address, Mr. Lyall, of Caddonlee, stated that probably part of the difference between the quality of the milks yielded by Nos. 3 and 4 ewes, which were both fed on first year's grass, might be due to the fact that No. 3 ewe grazed in a field which had the advantage of facing the south, and where the grass was more succulent and luxuriant, whilst No. 4 ewe grazed in a field lying to the north, and where the grass was not so succulent.)

The variation in the quality of ewe's milk is quite in keeping with the variations observed in the quality of cow's milk, as may be noticed from the following table, which gives the results of a large number of analyses of cows' milk taken from four dairies which supply milk to Edinburgh:—

Average.	Specific gravity of milk.	Cream per ct. by volume.	Total solids per cent. by weight.	Solids not fat, per cent. by weight.	Fat in solids per cent. by weight.	Ash in solids per cent. by weight.
Dairy.						
A. Morning milk	1031·46	7¼	11·827	9·395	2·432	0·70
B. " "	1032·14	8	11.95	9·50	2·453	0·69
C. " "	1033·0	8	12·36	9·91	2·45	0·69
C. Forenoon milk	1032·3	10	13·54	10·41	3·13	0·73
D. Morning milk	1033·5	6¼	11 23	9·36	1·87	0·71
D. Forenoon milk	1031·4	8¼	12·58	9·74	2·84	0·71
D. Afternoon milk.....	1030·8	9	12·43	9·52	2·91	0·72
Average of four dairies, representing forty-six cows and 66 samples of milk	1032·1	8¼	12·27	9·69	2·58	0·71
Differences in quality of milk, including all trials, but excluding partial runnings—						
Lowest	1028·3	5	10·57	8·62	1·56	0·62
Highest	1035·7	11	14·54	11·23	3·47	0·76
Difference.....	7·4	6	3·97	2·61	1·91	0·14

I have likewise examined, during the last month, five samples of goat milk. No. 1 sample was that taken from a goat—half-bred Egyptian—which had newly kidded; No. 2 sample was from the same goat on the day after kidding; No. 3 sample from the same goat during four days thereafter; No. 4 sample from the same goat on the seventh day; and No. 5 sample was taken from another goat where the milk was three weeks old. The results of the analyses of these milks were as follows:—

No. of sample.	Total solids per cent. by weight.	Solids not fat, per cent. by weight.	Fat in solids per cent. by weight.	Ash in solids per cent. by weight.
No. 1 goat milk	29 28	21·52	7·76	1·18
No 2 "	19·42	13·58	5·84	0·97
No. 3 "	18·26	12·51	5·75	0·96
No. 4 "	16·18	11·52	4·66	0·92
No. 5 "	13·43	9·12	4·31	0·73
Mean of all trials	19·31	13·65	5·66	0·95
Mean of Nos. 2, 3, 4, and 5, samples, excluding No. 1, being from goat newly kidded	16·82	11·68	5·14	0 89

The specific gravity and cream could only be conveniently taken in the case of No. 4 sample, where the specific gravity was found to be 1033·9, and the cream 13 per cent. by volume. The analyses demonstrate that when the goat drops the kid, the milk is extremely rich, and that the quality comes down day by day, till in three weeks it resembles, in composition, very rich cow's milk. It may be instructive to contrast side by side the quality of average cow's milk, average three weeks old ewe milk, and three weeks old goat milk, and the following table will enable us to do so:—

	Average cow's milk.	Average 3 weeks old ewe milk.	3 weeks old goat milk.
Total solids per cent. by weight	12·27	17·78	13·43
Solids not fat	9·69	12·06	9·12
Fat in solids	2·58	5·72	4·31
Ash in solids	0·71	0·94	0·73

It will thus be observed that goat milk is richer than cow milk, especially in fat, and that ewe milk is decidedly richer than either goat or cow milk on all points. It is probable that a knowledge of this fact may lead to the use of ewe milk by invalids and others desirous of having very rich milk as an article of diet.—*Pharm. Journ. and Trans.*

THE QUALITY OF MILK SUPPLIED TO TOWNS.

BY DR. STEVENSON MACADAM, F.R.S.E.*

The recent prosecutions in Edinburgh and other cities and towns, in reference to the adulteration of milk, have proved that there is great necessity for more full information regarding the chemical composition of genuine or normal milk. Consequently, having been professionally engaged in some of the cases of alleged adulteration, and having acquired a mass of results regarding the analysis of milk, I have thought it right to give publicity to these researches, in the hope that they may tend to afford greater certainty to future analysis of milk, and thus be of public service.

In carrying on the analysis of milk, the special points which may be determined are—

(1) Specific gravity of the milk.
(2) Percentage of cream by volume.
(3) " solids by weight.
(4) " solids not fat weight.
(5) " fat or butter "
(6) " ash in solids "

Where it is possible, all these points should be determined. Some chemists attempt to despise the specific gravity and cream tests, and stand by the solids and fat only; whilst others hold, and correctly so, that the specific gravity and cream determinations are excellent guides when they are properly carried out. Necessarily, when all the points are determined—the specific gravity as well as the solids, and the cream as well as the fat—both parties must be satisfied, as the one affords a check to the other, and double certainty and accuracy of results are obtained.

The *specific gravity* is best taken in the ordinary specific gravity bottle, holding 1000 grains of water at 60° F. The milk should be agitated previously, so as to mix the fat or cream thoroughly throughout, but care must be taken that the agitation is not so violent as to incorporate air cells with the milk. The temperature of the milk at the time should be 60° F. if possible, but, if slightly above or below that temperature, then an allowance of two-tenths may be made for every degree above or below, being added to the weight when the temperature is above 60° F., and being abstracted from the weight when the temperature is below 60° F. The hydrometers which are supplied with the ordinary lactometers are seldom correct, and, moreover, there is greater uncertainty in reading off the exact figure on the stem indicative of the specific gravity. I always employ the specific gravity bottle. Taking genuine milk derived direct from the udders of the cows belonging to three large dairies in the neighborhood of Edinburgh, I find the specific gravity to range from 1028·4 to 1035·7; the average of forty-four trials with different milks being 1032·20 (water = 1000·00). The variations in the specific gravity of the milk ranging over 7 degrees undoubtedly indicate a difference in the composition of the milks and in the quantities of the respective components.

The *cream* is determined in an elongated vessel of uniform width, and graduated at the upper part so as to indicate accurately from 1 to 25 per cent. of the whole capacity. The precautions necessary for the uniform and accurate estimation of the proportion of cream obtainable from milk by this creamometer are (1) that the vessels should be of similar size, so as to admit of the fat globules rising to the surface with equal facility; (2) that the milk should be taken as fresh from the cow as possible, or that, in contrasting the relative qualities of samples of milk, they should be taken about the same length of time from the cow; (3) that the milk should be well agitated before being placed in the graduated vessel; (4) that the temperature of the milk should be about 60° F.; (5) that the temperature of the room be kept about 60° F.; and (6) that the respective milks be allowed to remain in the creamometers for the same length of time, say twenty-four hours. Working in this manner, I find that genuine milk throws up a proportion of cream ranging from 5 to 11¼ per cent. by volume, whilst the average of forty-four trials gave 7·8 per cent.

The *total solids* in milk may be readily estimated by evaporating a given weight of the milk in platinum vessels heated on a water-bath. A convenient and excellent bath may be constructed from a common iron pot, about eight inches wide and four inches deep, covered with a sheet of copper-plate about ten inches square, which can be kept in its place by a band being cut out at each side and bent down to embrace the pot. Four circular openings are cut in the copper cover which admit of four flat platinum basins, about two inches in diameter, being set in the bath. The square corners of the copper cover form a hot plate when the bath is in working order. The milk to be tested having been agitated, a portion is poured into one of the platinum basins and weighed. The amount should run from 80 to 100 grains. The basin and contents are then placed on the water-bath, and the water kept briskly boiling for at least two hours. Probably to insure the thorough drying of the residue, three hours should be taken in all trials, so as to have uniformity in mode of working and greater accuracy in result. The basin and contents are then re-weighed, and the total solids from the given amount of milk are obtained. A calculation then gives the percentage of total solids by weight, and I find that genuine milk gives from 10·57 to 14·54 per cent., the average of forty-four trials being 12·04. There is thus a difference of 4 per cent. in the amount of solids obtainable from samples of genuine or normal milk.

The *solids not fat* are estimated by taking the total solids contained in the platinum basin, and extracting the fat by ether, at the same time heating gently over a vessel containing hot water. On settling for a minute, the ether may then be decanted off into a small weighed beaker. The ether treatment of the total solids should be repeated over three times, so that the solids are acted

* Read before the Pharmaceutical Society (North British Branch) at the meeting on the 26th March, 1874.

upon four times by the ether. On drying up the residue in the platinum basin, and re-weighing, the proportion of *solids not fat* in the amount of milk employed is obtained, and a calculation will give the percentage. Genuine milk gives from 8·74 to 11·23 per cent. of the solids not fat—the average of forty-four trials being 9·62 per cent.

The *fat* may be determined in two ways, either by the loss in weight of the total solids as compared with the solids not fat, or by the evaporation of the ethereal solution and weighing the fatty residue. I do not find the evaporation method so accurate as the estimation by loss. There is apparently some of the fatty matter which escapes over the side of the vessel even when the evaporation is conducted in glass beakers. The difference in weight between the total solids and the solids not fat gives always a higher result and one which I consider is more accurate. Taking, therefore, the loss in weight due to the extraction of the fat from the total solids by the ether, I find that genuine milk gives a percentage of fat ranging from 1·56 to 3·32, the average of forty-four trials being 2·44.

The *ash* in the solids is estimated by burning off the organic constituents and weighing the residue. In genuine milk the ash ranges from 0·62 to 0·76 per cent., the average being 0·69 per cent.

In carrying on these researches, genuine milk was obtained in every instance direct from the udder of the cow. My assistant, Mr. William Jack, went to three large dairies and personally took the samples. He inspected the pails before the milking was commenced, saw all the cows milked, and sampled every milk himself.

From dairy A there were altogether 16 samples taken from 14 cows, 12 of the samples were from the entire runnings of milk from 12 cows, whilst two of the samples were the first of the runnings, and the remaining two samples were the last of the runnings from the remaining two cows. The first five and the last five of the 16 samples were fully analyzed, and the results are given in the following table :—

No. of Cow.	Specific gravity of milk.	Cream per ct. by volume.	Total solids per cent. by weight.	Solids not fat, per cent. by weight.	Fat per cent. by weight.	Ash in solids per cent. by weight.
1*a* first of runnings.....	1032·9	7	11.57	9·32	2·25	0·71
1*b* last of runnings	1031·2	10	12·32	9·30	3·02	0·68
2 whole runnings	1033·4	5¼	11·39	9·52	1·87	0·72
3*a* first of runnings.....	1034·1	5	11·25	9·28	1·97	0·69
3*b* last of runnings.....	1029·4	11½	13·66	9·32	4·34	0·70
10 whole runnings	1030·4	6	10·57	8·74	1·83	0·67
11 "	1032·7	5	11·42	9·70	1·72	0·70
12 "	1031·	6	11·51	9·55	1·96	0·69
13 "	1031·1	9	12·62	10·04	2·58	0·74
14 "	1028·4	10	11·96	9·18	2·78	0·70
Average of the 10 samples.	1031.46	7¼	11·827	9·395	2·432	0·70

From the above table it will be observed, that, taking the whole runnings, the specific gravity of the milk ranged from 1028·4 to 1033·4, the cream from 5 to 10, the total solids from 10·57 to 12·62, the solids not fat from 8·74 to 10·04, the fat from 1·72 to 2·78, and the ash from 0·67 to 0·74; whilst the average of the ten experiments gave specific gravity 1031·46, cream 7¼, total solids 11·827, solids not fat 9·395, fat 2·432, and ash 0·70.

The samples of first runnings were markedly inferior in quality, whilst the samples of last runnings were as markedly superior in quality; in No. 1 cow the proportions of cream being 7 to 10 and fat 2·25 to 3·02, whilst in No. 3 cow the variation in cream was 5 to 11¼, and the percentage of fat 1·97 to 4·34. It may be stated that the cows, Nos. 1, 2, 10, 11, 12, 13, and 14 were of the "cross" breed, whilst No. 3 was an "Ayrshire;" that Nos. 1 and 2 had calved in January, No. 3 in November, Nos. 10 and 11 in June, No. 12 in December, and Nos. 13 and 14 in July; and that the cows were fed three times a day, viz.: at 7 A. M. mash of draff, oilcake, and boiled turnips; at 12 noon draff and raw potatoes; and at 7 P. M. mash, raw turnips, and hay.

From dairy B there were 22 samples of milk taken, 18 of which were from the whole runnings of 18 cows, whilst two samples were the first runnings, and two samples were the last runnings of milk from other two cows. All of these samples were fully analyzed and the following results were obtained :—

No. of Cow.	Specific gravity of milk.	Cream per ct. by volume.	Total solids per cent. by weight.	Solids not fat, per cent. by weight.	Fat per cent. by weight.	Ash in solids per cent. by weight.
1*a* first of runnings.....	1033·6	5	10·47	9·15	1·32	0·67
1*b* last of runnings	1030·5	12	12·94	9·17	3·77	0·73
2 whole runnings	1032·5	8	12 57	9·88	2·69	0·74
3 "	1033·7	7	11·75	10·19	1·56	0·71
4 "	1031·4	8	11·91	9·32	2·59	0·68
5 "	1031·8	10	12·18	9·24	2·94	0·65
6*a* first of runnings	1033·4	5	10·57	9·03	1·54	0·62
6*b* last of runnings	1029 0	14	14·09	8 99	5·10	0·59
7 whole runnings	1032·9	7¼	12·17	9·93	2·24	0 65
8 "	1032·5	7¼	11·97	9·70	2·27	0·67
9 "	1031·5	7½	11·52	9 23	2·29	0·62
10 "	1032 8	6	11·24	9·55	1·69	0·71
11 "	1032·8	7	11·84	9 73	2 11	0·72
12 "	1030·8	9¼	11 66	8·94	2·72	0·64
13 "	1030·6	9	11 98	9·37	2·61	0·68
14 "	1033 5	8	12·33	9 95	2·38	0·72
15 "	1031	6	11·48	9·52	1·96	0·73
16 "	1033·4	6	11·37	9·73	1·64	0·70
17 "	1032·7	6	11·29	9·54	1·75	0·75
18 "	1029·6	8	11·41	8·85	2·56	0·69
19 "	1034·0	10	13 85	10 79	3·06	0·76
20 "	1031·3	11	12·48	9·16	3·32	0 68
Average of the 22 samples.	1032·14	8	11·95	9·50	2·453	0·69

Taking the above analyses and leaving out the special experiments on the first and last of the runnings of the two cows, Nos. 1 and 6, it will be found that over the whole runnings given by each cow, the specific gravity ranged from 1029·6 to 1034·0, the cream from 6 to 11, the total solids from 11·24 to 13·85, the solids not fat from 8·85 to 10·79, the fat from 1·56 to 3·32, and the ash from 0·62 to 0·76, whilst the average of the whole 22 analyses gave specific gravity 1032·14, cream 8·0, total solids 11·95, solids not fat 9·50, fat 2·453, and ash 0·69. The samples of first runnings were again much inferior in cream and fat to the last runnings; thus in cow No. 1 the difference was in cream 5 to 12, and fat 1·32 to 3·77, whilst in cow No. 6, the variation in cream was 5 to 14, and in fat 1·54 to 5·10. In this dairy the cows Nos. 1, 7, 8, 9, 10, 11, and 12 were English, Nos. 2, 3, 4, 5, 6, 13, 14, 15, 16, 17, 18, and 20 were Ayrshire, and No. 19 was a cross; and the calving of the cows had taken place in January for Nos. 1, 8, and 9; October for Nos. 2, 3, 4, 5, and 6; December for Nos. 7, 10, 11, 12, and 13; August for Nos. 14, 15, and 18; September for Nos. 16 and 17; June for No. 19, whose milk was nearly out; and February for No. 20, whose milk was only two weeks old. All the cows were fed three times a day on draff and raw turnips.

From dairy C, 12 samples of milk were taken from 12 different cows, and gave the following analytical results:—

No. of Cow.	Specific gravity of milk.	Cream per cent. by vol.	Total solids per cent. by weight.	Solids not fat, per cent. by weight.	Fat per cent. by weight.	Ash in solids per cent. by weight.
1. Whole runnings	1031·5	9	12·92	9·94	2·98	0·72
2. "	1031·6	10	12·73	9·71	3·02	0·69
3. "	1032 6	9	12·94	10 15	2·79	0·73
4. "	1034·8	6	11·96	10·22	1·74	0·65
5. "	1034·4	6	11·88	10·04	1·84	0·68
6. "	1031·9	6	10·92	9·16	1·76	0·62
7. "	1032·9	6	11·04	9·34	1·70	0·64
8. "	1035·7	11	14·54	11·23	3·31	0·73
9. "	1030·4	8	11·93	9·37	2·56	0 69
10. "	1031·8	8	12·22	9 69	2·53	0·70
11. "	1034·4	10	13·33	10·02	3·31	0·71
12. "	1034·3	6	11·93	10·07	1·86	0·69
Average of the 12 samples	1033·0	8	12·36	9·91	2·45	0·69

The above results show that in dairy C, the milk also varied much in all the testing qualities. Thus, the specific gravity ranged from 1030·4 to 1035·7, cream from 6 to 11; total solids, from 10·92 to 14·54; solids not fat, from 9·16 to 11·23; fat, from 1·74 to 3·31; and ash, from 0·62 to 0·73; whilst the average of the whole 12 samples gave specific gravity 10·33, cream 8, total solids 12·36, solids not fat 9·91, fat 2·45, and ash 0·69. In this dairy, the cows, Nos. 1, 2, and 9, were Ayrshire; Nos. 3, 4, 5, 6, 7, 8, and 12, were cross; and Nos. 10 and 11 were English; and the food consisted of draff, turnips, and oilcake at 5.30 A. M., draff and turnips at 12 noon, and draff, turnips, and oilcake at 6 P. M.

The average quality of the milk supplied to Edinburgh by the three dairies may be better observed by placing the averages side by side and then striking an average of the whole samples derived from the 40 different cows. This average of the whole trials may then be contrasted with the lowest and highest results obtained from the whole samples in specific gravity, cream, total solids, solids not fat, fat, and ash. The following table exhibits these points:—

	Specific gravity of milk.	Cream per cent. by vol.	Total solids per cent. by weight.	Solids not fat per cent. by weight.	Fat per cent. by weight.	Ash in solids per cent. by weight.
Dairy A average	1031·46	7⅛	11·827	9·395	2·432	0·70
" B "	1032·14	8	11·95	9·50	2·453	0·69
" C "	1033·00	8	12·36	9·91	2·45	0·69
Average of 3 dairies, representing forty cows' milk	1032·2	7·8	12·04	9·60	2·44	0·69
In all trials—						
Lowest	1028·4	5	10·57	8·74	1·56	0·62
Highest	1035·7	11¼	14·54	11·23	3·32	0·76

These latter figures show that the specific gravity of milk of undoubted genuine quality may range from 1028·4 to 1035·7, or more than 7 degrees, the cream from 5 to 11¼, or more than double; the total solids from 10·57 to 14·54, or 4 per cent.; the solids not fat from 8·74 to 11·23, or 2½ per cent.; the fat from 1·56 to 3·32, or more than double; and the ash from 0·62 to 0·76.

These results prove conclusively that milk taken from different dairies varies in chemical composition, and that milk taken from different cows in the same dairy varies still more in chemical properties, notwithstanding that the cows are housed in the same way, fed at the same time and manner, and milked at the same hours. No doubt the quality of the milk must be influenced not only by the food but by the water in the food, the temperature of the barn, the season of the year, whether summer or winter, as well as probably the breed of cow, age, time of calving, and exact state of health of each cow at the time of milking.

The beneficial effects of improved feeding are apparent in several trials which I have made since the foregoing results were tabulated, on the milk of four of the cows belonging to dairy C. The milk was taken from the cows during the day, when it is generally supposed that the milk is richer; but besides that, the dairyman stated that he had commenced to give his cows more nutritious food. The analytical results of the testing of these latter samples of milk were as follows:—

No. of Cow.	Specific gravity of milk.	Cream per cent. by vol.	Total solids per cent. by weight.	Solids not fat per cent. by weight.	Fat per cent. by weight.	Ash in solids per cent. by weight.
1. Whole runnings	1032·5	12	14·41	10·47	3 94	0·73
2. "	1033·6	7½	12·64	10·41	2·23	0·71
3. "	1033·3	10	14·21	11 05	3·16	0·75
4. "	1030·	10	12·91	9·70	3·21	0·74
Average of the 4 samples	1032·3	10	13·54	10·41	3·13	0·73

These results show a decided increase in the proportion of the several ingredients in the milk, due apparently to the better feeding of the cows.

An important point regarding the time and mode of sampling milk requires now to be considered. When the milk is brought into the sale shop, it is generally placed in a large sale can, from which portions are removed by a measure now and again, as demand requires. During the sale of the milk the process of creaming is going on slowly, and as the fat rises to the surface and the sale measure is being dipped in the milk which is thus removed becomes richer in cream or fat, so that in course of time the milk which is left behind becomes poorer, owing to the floating up and removal of part of the cream or fat originally diffused through it. Milk begins to cream immediately on being set at rest, and the mere disturbance of the upper half of the contents of a vessel will not reintermingle the cream with the whole milk, and thus keep up the original composition.

I have made special trials to determine the effects of the sale "ladling" process on the quality of the remaining milk. In the first experiment the original milk gave ten per cent. of cream; after a process of sale removals for one hour, the remaining milk only showed nine per cent. of cream when allowed to stand; and after sale removals for three hours, the remaining milk only gave seven per cent. of cream. A second trial was made with a mixture of twenty-two samples of milk, and a portion of the original mixture of milk was analyzed side by side with another portion, which had been subjected to the ladling process for three hours. The results were as follows:—

	Original mixture.	Remainder of milk in sale can in three hours.
Specific gravity	1032	1033.1
Cream p. c. by volume . .	9	6
Total solids p. c. by weight	12·06	11·39
Solids not fat " "	9·67	9·58
Fat " "	2·39	1·81
Ash in solids " "	0·70	0·67

It was thus apparent that during the period milk is retained in a sale can, and successive quantities ladled out from time to time, the remaining milk becomes poorer in quality through loss of cream or fat, and in the space of three hours the proportion of fat is reduced by twenty-five per cent., or one-fourth of the whole.

In endeavoring to fix on a standard for genuine milk, and which might be fairly deducible from the foregoing experimental results, I am of opinion that taking large dairies, where the runnings of a number of cows can be thrown together, so as to equalize the rich and the poor milk and yield an average, the following proportions may be taken as a standard for genuine or normal milk:—

Specific gravity . .	about 1030	
Cream . . .	not under	6 per cent.
Total solids .	"	11 "
Solids not fat .	"	9 "
Fat	"	2 "
Ash in solids .	"	0.65 "

But we must be prepared for even lower results in individual cases, as in dairies where only one, two, or three cows are kept, and where they are probably not very well fed. Even in the larger dairies, where the milk of the cows is not mixed together, or where probably the milk of every two or three cows is simply placed in a can by itself, there might occasionally be found a sample having a lower composition than the standard given above, and yet the milk be undoubtedly of genuine quality. Any difficulty in this respect, however, would be avoided by the whole milkings of the dairy being placed in a large common vessel, and thereafter the sale or town cans filled from this mixture of the whole runnings of the dairy.

The foregoing experimental results of the analyses of the samples of milk taken direct from the udders of forty cows belonging to three large dairies, prove that the standard for genuine or normal milk which has recently been put forward for the guidance of city analysts is far too high. The assumed standard declares that normal milk must have 12·5 per cent. of total solids, of which 9·3 per cent. are solids not fat, and 3·2 per cent. must be fat. This so-called standard has been assumed in the face of an analysis of *average country milk*, which is also quoted, and which *average* milk contains actually less than the assumed standard, which ought to indicate *minimum* and not *average* quality of genuine milk. According to this so-called standard, adopted in so arbitrary a manner and blindly followed by town analysts, by far the greater number of the samples of milk taken direct from the udders of the forty cows in the dairies A, B, and C, would be held to be adulterated, either with water or with skimmed milk or with both, and taking the average of the whole of the samples of milk, which shows only 2·44 per cent. of fat, we find that it contains about 25 per cent. less fat than the assumed standard, so that the entire bulk of the genuine milk yielded by the forty cows, if mixed together in equal quantities, would be held to be adulterated with about 25 per cent. of skimmed milk. The results obtainable from the assumed high standard should not, therefore, be depended upon; and yet by calculation from such data, carried out to the tenths and hundredths of a grain, we find prosecutions taking place and convictions attempted to be obtained and enforced.

The assumption of a definite high standard for milk, and the further assumption that all milk is of equal, or nearly equal, quality, is even directly contrary to all previous researches on the subject, as shown by the great diversity in the composition of milk as given in analyses published in different chemical treatises. Even the amount of fat in cows' milk on which the proportion of adulteration with skimmed milk is based, is authoritatively stated to be sometimes as low as 1·25, 1·4, 2·13, though ranging up to 3·42, 4·56, etc., showing great variations in the amount of this ingredient. Probably the best evidence on this point is given in a Government report, written by Prof. John Wilson, in 1866, where the Danish dairy farms are referred to, and where the variations in the amount of fat in milk are observable in the amount of milk required to yield a pound of butter at different seasons of the year. The proportions range in the same dairy farm from 19½ to 33 lbs. of milk, and in another dairy farm from 21½ to 31½ lbs. of milk, which must be employed to yield a pound of butter.

Since the analyses of the samples of milk were made by me, and I was called upon to give evidence in two cases of alleged adulteration, there has been published in the *Pharmaceutical Journal*, an excellent paper by Prof. Voelcker, "on Milk, its Supply and Adulteration," in which he gives the results of the analyses of the milk yielded by the herd of cows at the Royal Agricultural College, Cirencester, during eleven months of a year, and shows the great variations which occur in the quality of the milk obtained from the whole herd. The total solids range from 9·3 to 13·8 per cent., and the fat from 1·79 to 4·12 per cent., and judging from the assumed higher standard adopted by some town analysts, the whole runnings of this herd of cows would have been declared to be adulterated for two-thirds of the year.

The Adulteration Act was framed for the protection of the public, and, if properly worked out, would undoubtedly lead to the suppression of adulteration in food, drink, and medicine, and would at the same time be of national service, and a protection to the honest merchant against the dishonest and fraudulent dealer. But if anything is calculated more than another to render the Act inoperative and untrustworthy, it is the framing and setting up of a standard of genuineness which can seldom be reached by the genuine article itself, and by blind adherence to which the majority of the samples of the genuine and unadulterated material must be declared to be mixed and adulterated.

Considering the great variations in the quality of genuine milk, and the beneficial effects of the good feeding of the cows upon the milk, it is worthy the attention of dairymen whether they would not sell their milk under a guarantee of quality, say 11 per cent. of total solids, of which 9 are solids not fat and 2 are fat. In large dairies this could be insured by mixing the whole runnings of the milking of the herd in a common tank, and thereafter filling the sale or town cans from this mixture of the whole milking. Milk could thus be sold with a guarantee which would give certainty to the purchaser that he was obtaining not only genuine milk, but genuine milk of good quality.

Since reading the foregoing paper before the meeting

of the Society, I have had the opportunity of testing the quality of the milk yielded by the cows in another dairy which supplies milk to Edinburgh. This dairy, which we may call dairy D, contained six cows at the time complaints were lodged against the genuine character of the milk, and I have tested the quality of the milk given by each of these six cows in the morning, at noon, and in the afternoon. My assistants, Mr. William Ivison Macadam and Mr. Charles Edward Bourchier, went to the dairy on each occasion, inspected the milk pails, saw all the cows milked, sampled each milk from the whole runnings taken from the udder of each cow, and brought the samples to me in a locked case. The analyses were made by me in the manner stated before, and the results obtained are given in the following table:—

No. of Cow.	Specific gravity of milk.	Cream per cent. by vol.	Total solids per cent. by weight.	Solids not fat, per cent. by weight.	Fat per cent. by weight.	Ash in solids, per cent. by weight.
Morning milk.						
1. Whole runnings	1034·5	6	11·52	9·76	1·76	0·72
2. "	1033·3	5	10·63	9·05	1·58	0·68
3. "	1033·4	6	10·96	9·22	1·74	0·69
4. "	1032·3	8	12·29	9·75	2·54	0·74
5. "	1033·3	6½	11·04	9·18	1·86	0·71
6. "	1034·1	6	10·95	9·21	1·74	0·73
Average of morning milk	1033·5	6¼	11·23	9·36	1·87	0·71
Noon milk.						
1. Whole runnings	1033·1	8	12·94	10·23	2·71	0·71
2. "	1030·9	9	12·78	9·66	3·12	0·70
3. "	1032·2	7	11·42	9·26	2·16	0·72
4. "	1030·6	8	11 98	9·37	2·61	0·73
5. "	1030·7	8⅛	12·66	9·70	2·96	0·70
6. "	1030·9	10	13·73	10·26	3·47	0·72
Average of noon milk	1031·4	8⅛	12·58	9·74	2·84	0·71
Afternoon milk.						
1. Whole runnings	1033·0	7½	12·52	10·08	2·44	0·73
2. "	1031·1	8	12·09	9·33	2·76	0·71
3. "	1030·2	10	13·11	9.86	3·25	0·73
4. "	1028·3	8	11·25	8·62	2·63	0·74
5. "	1031·4	9⅛	12·81	9·69	3·12	0·70
6. "	1030·8	10	12·84	9·58	3·26	0·72
Average of afternoon milk	1030·8	9	12·43	9·52	2·91	0·72
Total average of morning, noon, and afternoon milk	1031·9	8	12·08	9·54	2·54	0·71

These results prove that, taking either a single cow or the whole herd, the morning milk did not come up to the assumed high standard of 12·50 of total solids, of which 9·30 are solids not fat, and 3·20 are fat; the noon milk only gave one sample above the standard, whilst the five remaining samples were below the standard; and the afternoon milk gave two samples equal to the standard, and four samples below it. Of the whole eighteen samples only three were up to the standard and fifteen were below it, so that the milk of these fifteen cows would have been declared mixed or adulterated with water, or skimmed milk, or with both water and skimmed milk, according to the assumed high standard. Again, taking the whole morning milk, the whole noon milk, or the whole afternoon, separately or together, the entire runnings of this dairy would, on the same standard, be declared to be adulterated.

The differences in the quality of the milk yielded by the same cow at different periods of the day, and the variations in the character of the whole milk given by the whole herd at morning, noon, and afternoon, are markedly observable in the results obtained from dairy D. It is quite apparent that the morning milk is the poorest, whilst the noon and afternoon milks are decidedly richer. It may be stated that all of those cows were of the Ayrshire breed, that they were fed on draff, turnips, oats, straw, and peas meal; that No. 1 cow calved in August, and the milk was almost out; Nos. 2 and 5 calved in February; No. 3 in January; and No. 6 in September, and the milk of the latter was nearly done.

In conclusion, I may mention that out of 66 samples of genuine milk taken from 46 cows, and which have been fully analyzed by me, only eleven of these samples came up to the high standard of 3·2 per cent. of fat, of which one sample was of the last runnings of the milk, and three samples were deficient in the high standard of 9·3 of solids not fat; so that only seven samples of the whole runnings of milk came up to the assumed high standard on all points. Neither the average quality of the genuine milk obtained from any one of the four dairies, nor the average quality of the genuine milk yielded by all the dairies taken together, was equal to the arbitrary high standard assumed by City Analysts.—*Pharm. Journ. and Trans.*

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS.

In the preparation of these abstracts the Editors are assisted by the following chemists:—

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Annalen der Chemie.

Vol. 175, Nos. 1 and 2.

On the constitution of **phosphorous ethyl ether and phosphorous acid.**—Carl Zimmerman.—Phosphorus is triatomic in its combinations, and ethyl phosphite is shown to be $P\begin{cases}OC_2H_5\\OC_2H_5\\OC_2H_5\end{cases}$ and cannot be $P\begin{cases}O\\C_2H_5\\OC_2H_5\\OC_2H_5.\end{cases}$

Contribution on the conversion of substituted **thioureas into guanidine.**—Carl Forster.—The action of mercuridiphenylammonium chloride, or phenylated white precipitate in withdrawing sulphur from sulpho-ureas, is studied.

On the action of **ethylidine oxychloride on zinc ethyl.**—Dr. Friederich Kessel.—Secondary butyl ether

is the principal product, formed according to the equation—

$(CH_3CHCl)_2O + Zn(C_2H_5)_2 = ZnCl_2 + (CH_3CHC_2H_5)_2O$.

This was converted into the iodide and corresponding alcohol.

On **gentianin.**—H. Hlasiwetz and J. Habermann.—At the Vienna Exposition, Trommsdorff exhibited a large quantity of this substance in fine crystals. By fusion with alkali, and dissolving in dilute sulphuric acid, then treating with ether, the latter takes up three compounds which can be readily separated. By evaporating the ether and treating the residue with water, and distilling, acetic acid comes over. In the retort remains phloroglucin and gentisinic acid, $C_7H_6O_4$. By fusion and sublimation is obtained, from this, pyrogentisinic acid, $C_6H_6O_2$.

Researches on the **coloring matter of gall.**—Richard Maly.—The formula of biliverdin is $C_{16}H_{18}N_2O_4$.

On the **nitro-compounds of the fatty series.**—Victor Meyer.—Nitrolic acids, a new class of organic nitro-compounds.

Note on the history of **hydroxylamine.**—V. Meyer.

On **primary isonitrobutan.**—Eugene Demole.—By the action of potassic nitrate and sulphuric acid a nitrolic acid is obtained, as shown by its conduct with reagents. It could not be analyzed, as it was not obtained in a pure condition and was not crystallizable.

Contributions to the knowledge of **azo-compounds.**—William Michler.—Embracing the action of sodium amalgam upon dinitro-compounds.

Constitution of tannates.—Hugo Schiff.—A number of these salts have been studied and are here described, and confirm the conclusions reached in a former article—that this acid is an anhydride of gallic acid, and has the formula—

$$\left.\begin{matrix} C_6H_2 \begin{cases} CO.OH \\ OH \\ OH \\ O \end{cases} \\ C_6H_2 \begin{cases} CO \\ OH \\ OH \\ OH \end{cases} \end{matrix}\right\} = C_{14}H_{10}O_9$$

On the conduct of **neurine towards albumenoids.**—Julius Manthner.—Neurine, in dilute solution, dissolves fibrin, which is again precipitated by acids. The albumen of hen's eggs is dissolved also and not coagulated by boiling. Coagulated albumen is dissolved by the same solution.

On the acid **(levulinic acid) obtained by the action of sulphuric acid on sugar.**—A. Freihenn v. Grote and B. Tollens.—This acid is obtained by treating the solution obtained by heating sugar and sulphuric acid with baric carbonate, evaporating, extracting with alcohol, precipitating barium with sulphuric acid, and, after concentrating, dissolving in ether. On distillation the ethereal solution yields an acid syrup. From this the zinc salt of the acid is obtained by saturation with oxide of zinc. The free acid has the formula $C_5H_8O_3$, distills at about 260°, and fuses at about +11°.

On **vegetable gums.**—W. Kirchner and B. Tollens.—Not suited for abstraction.

Constitution of the **uric acid group.**—Dr. Ludwig Medicus.—This article opens with a description of the preparation of oxonic and lantanuric acids, first obtained by Streeker by the oxidation of uric acid in alkaline solution by atmospheric oxygen. The potassium salt is $C_4H_3K_2N_3O_4 + 1\frac{1}{2}H_2O$. The remainder of the article is principally a discription of the constitution of the compounds of this group.

Conduct of diacetonamine hydrochlorate when heated.—W. Heintz.—By distillation at 130°–140°, passed over a colorless liquid. The temperature finally rose to 180°, and a brown residue remained in the retort containing a large quantity of ammonic chloride and a base not identified. The author believes, however, that acetone is formed. Mesityl oxide was formed, and this indicated something as to the chemical structure of the latter.

No. 3.

On the amido-derivatives of hydroxylamine.

1. On the **formation of diphenylurea from** dibenzhydroxamic acid, and the conversion of benzoic acid into anilin.—H. Rotermund.—Potassic dibenzhydroxamate in aqueous solution is readily decomposed, forming carbonic acid and potassic benzoate, and an insoluble substance found to be diphenyl urea. The reaction is—

$2N(C_7H_5O)_2OH + H_2O = C_{13}H_{12}N_2O + 2C_7H_5O_2K + CO_2$.

2. On the **structural formula of hydroxylamine and its amido-derivatives.**—W. Lossen.—The most probable formula is $N{-}H(/H)(\backslash O{-}H)$. A somewhat lengthy article, embracing the results of the author's investigations.

3. On the **distillation of dihydroxamic acids.**—Dr. F. Pieschel.—Dibenzhydroxamic acid when heated is decomposed into carbonic acid, after which the remaining liquids furnished, on fractional distillation, phenyl cyanate, benzoic acid, and the residue in the retort benzanilide.

4. **Methods to replace the carboxyl groups of aromatic acids by the amide groups.**—W. Lossen.—This article describes the manner of this substitution in a number of acids.

On the **ether of dihydroxamic acid.**—Dr. E. Eiseler.—A description of several ethers, not suited for abstraction.

Properties of **normal butylic acid and its salts.**—N. Grabowsky.

On the action of **nitric acid on normal butyl sulphide.**—N. Grabowsky.—Nitric acid acts upon this substance energetically at ordinary temperatures, and forms the oxide of the normal sulphide, $(C_4H_9)_2SO_2$, which crystallizes in needles, with a fusing point of 32°. It decomposes on distillation, is insoluble in water, very soluble in ether and alcohol.

By reduction it furnishes mercaptan.

Synthesis of diethyl carbinol, a new isomer of amyl alcohol.—George Wagner and Alexander Saytzeff.—This carbinol is obtained by the action of one molecule formic ether, four molecules ethyl iodide, and a small quantity of zinc sodium amalgam with finely divided zinc.

The iodide boils at 145° (763·8 mm. at 0°). Sp. gr. at 16° = 1·505.

New synthesis of secondary butyl alcohol.—J. Kanonnikoff and A. Saytzeff.—The new method of synthesis of secondary alcohol was applied successfully in this case, the alcohol being obtained by the action of zinc on a mixture of ethyl iodide, methyl iodide, and formic ether.

A notice concerning the preparation of **chloranhydrides of the fatty acids.**—J. Kanonnikoff.—The acids are treated directly with phosphorus oxychloride.

A notice on the **preparation of pseudopropyl alcohol**.—F. Flarvitzky.—Pseudopropyl alcohol was obtained by the action of water on pseudopropyl iodide, the acid liberated being neutralized with plumbic hydrate. The decomposition was complete and entirely satisfactory.

An improved **apparatus for fractional distillation**.—G. Glinsky.—For a clear description of this apparatus the accompanying plate is necessary.

Notice on the composition of the **platinum compound of dehydrotriacetonamine**.—W. Heintz.—Further notice and correction of a former article on the "ammonia derivatives of acetone." R. H.

Journal für Praktische Chemie.

Nos. 4, 5, 6, 7, and 8, 1874.

On the relations of **affinity between bases and acids**.—G. Weidemann.—Attempts to show in what proportions a body dissolved in water unites with two other bodies in solution to form compounds with them, as a base with two acids, have been made by numerous chemists; first Berthollet, then J. Thomsen, who measured the changes of temperature accompanying the chemical action, and Krecke who studied the dissociation of aqueous solutions of ferric chloride. The author pursues the subject further, taking advantage of the magnetism of solutions of the salts of magnetic metals, to obtain the needed data. For particulars of the method of experimenting and the philosophical discussion of the results we refer to the original paper.

On the substances producing the **acidity of urine**.—Dr. Jul. Donath.—(From the Sitzungsberichte der K. Akademie der Wissenschaften zu Wein.)

The acid reaction of normal urine has been ascribed by Liebig to the acid phosphates. He showed in fact that a mixture of ordinary sodium phosphate with uric and hippuric acids gives an acid reaction. The author of this article repeats Liebig's experiment, and after discussing some apparently anomalous results concludes that the second (possibly also the third) sodium atom of sodium phosphate behaves towards hippuric, benzoic, and uric acids like free alkali; but that the equilibrium of the salts thus produced is disturbed by even slight external changes giving rise to the formation of hydrodisodic or tri-sodium phosphate, and the free acid.

On the **dis-illumination of flames by nitrogen** and other gases.—W. Stein.—The power possessed by nitrogen and other inert gases of depriving illuminating flames of their photogenic properties, previously studied by Knapp, is explained by the author of the present article, as due to the oxygen of the surrounding atmosphere penetrating the flame.

On the **detection of aloe** and other bitter principles.—O. Bach.—Qualitative reactions of the following bitter principles frequently found in pharmaceutical preparations are here given: aloe, colocynth, wormwood, gentian, agaric (*Boletus laricis*), scammonium, and jalap.

On the preservation and properties of **palladium** foil supercharged with hydrogen by means of electrolysis.—Rud. Boettger.—The author corrects a statement previously published by him, to the effect that palladium possesses the property of exerting a reducing action on certain solutions of salts, even when not charged with hydrogen. He was led into this error by the fact that when palladium-hydrogenium is heated so hot that water dropped on it makes a hissing noise, it still retains hydrogen and can reduce a ferricyanide solution to a ferrocyanide. A lengthy heating to redness is necessary to drive out all the hydrogen. Boettger finds nickel, cobalt, and tin to possess similar properties with palladium, but Cd, Zn, Al, Cu, In, Pb, Sb, Hg, Bi, Au, Ur, Os, Pt, Cr, and Si do not absorb hydrogen.

Hydrogenium palladium may be preserved under boiled water or in absolute alcohol or ether for many days without losing hydrogen.

On a **phosphide of nickel**.—Dr. R. Schenk.—By the action of phosphoretted hydrogen on nickelous hydrate, the author obtains a body having the composition

$$N_4P_2 \text{ or } \begin{matrix} Ni{-}P{\equiv}Ni \\ \| \\ Ni{-}P{\equiv}Ni. \end{matrix}$$

On a new method for the **volumetric determination of silver**.—J. Volhard.

(From the Sitzungbericht der math. phys. Classe der K. Bayer, Akademie der Wissenschaften, 1874, 1.)

Sulphocyanides give in acid silver solutions white cheesy precipitates resembling silver chloride and equally insoluble in water; by adding some ferric sulphate to the argentic solution, the blood-red color of ferric sulphocyanide furnishes a delicate and marked end reaction. The method is generally applicable, and can be used for determining bromine, iodine, chlorine by means of what is known as residual titering.

To prepare a standard solution of ammonic sulphocyanide, dissolve about 8 grammes of the salt in 1 litre of water, then determine the exact value of this solution by means of a silver solution of known strength. Add ferric sulphate to determine the end reaction. In determining silver in alloys, copper (even as high as 70 per cent.) is without effect on the results.

Examination of the **derivatives of glycerine**.—L. Henry.

(From the Bull. de l'Acad. de Belg. [2] xxxvii. No. 1.)

On derivatives of diallyl.

Benzol, C_6H_6 may be considered as di-propargyl $C_3H_3{-}C_3H_3$. If this is correct it must be octovalent; that this is the case is shown by the formation of an octobromide of di-propargyl $C_6H_6Br_8$. This body forms fine large prisms on crystallizing from its solution in CS_2.

Contributions to our knowledge of the **triclinic feldspar**.—Theodor Petersen.—The author gives the following formulæ to these minerals:—

Monoclinic orthoclase.
$RAl_2Si_6O_{16}$ [R = K_2]

Triclinic Albite.
$RAl_2Si_6O_{16}$ [R = Na_2]

Oligoclase.
$RAl_2Si_5O_{14}$ [R = $Na_2.K_2.Ca$]

Andesite.
$RAl_2Si_4O_{12}$ [R = $Na_2 + Ca$]

Hyalophane.
$RAl_2Si_4O_{12}$ [R = $K_2 + Ba$]

Labradorite.
$RAl_2Si_3O_{15}$ [R = $Ca.Na_2$]

Anorthite.
$RAl_2Si_2O_8$ [R = Ca]

On a convenient method for **pulverizing alkaline chlorates and alkaline earths**.—A. Gawalovski.—Panes of glass dipped into the hot saturated solutions emerge coated with thin films, which, when scraped off, form a fine powder.

Contributions to our knowledge of **anthracene and chrysene**.—Ernst Schmidt.—This valuable paper of forty-eight pages cannot be abstracted so as to do it full justice. The author does not favor regarding chrysene as the fourth member of the benzol series.

Communications from the Laboratory of Prof. Wiedemann.

I. Remarks on the relations between **allophanic, oxaluric, and alloxanic acids.**—F. Salomon.

II. On **isocyancarbonic ether.** Warning!—F. Salomon.—Desirous of obtaining a body isomeric with Weddige's cyancarbonic ether, the author examined the action of urethan on chloroform in alcoholic solution and in presence of potassic hydrate. A violent reaction set in, but the author's labors were brought to a sudden termination by accidentally inhaling the new body. His whole body was convulsed, and he became insensible. His health has suffered much, and, being benevolently disposed to his brother chemists, he publishes this *warning*.

III. On the action of **chlorides on amides.**—P. Kretzschmar and F. Salomon.

IV. Preparation of **succinyldiurea.**—R. Conrad.

On **calcium glycolate.**—L. Carius.—A correction as to the crystallized anhydrous salt previously described by Fahlberg.

Communication on **artificial crystals of antimony.**—H. Laspeyres.—A physical crystallographic examination of some antimony crystals which formed accidentally in lead antimony works at Stolberg near Aachen.

On the **desulphurization of sulphureabenzoic acid** (dicarboxylsulphocarbanilide).—Peter Griess.—The reaction is effected by mercuric oxide, thus:—

$$C_7H_5\left\{\begin{matrix}NH\\(CS)''\\NH\end{matrix}\right\}\begin{matrix}O_2\\O_2\end{matrix} + HgO = C_7H_5\left\{\begin{matrix}NH\\(CO)''\\NH\end{matrix}\right\}\begin{matrix}O_2\\O_2\end{matrix} + HgS.$$

On the composition of **wool-fat.** (Second paper.)—Ernst Schulze and A. Urich.—Wool-fat consists of free cholesterine, iso-cholesterine, and compound ethers of this alcohol, together with a certain proportion of uncombined alcohols and acids.

Chemical examination of the **warm mineral spring in the Royal "Wilhelmheilsanstalt" at Wiesbaden.**—R. Fresenius.—The following is the result of the analysis:—

	Parts in 1000.
Sodium chloride	6·731518
Potassium "	0·227765
Lithium "	0·009752
Ammonium "	0·015870
Calcium "	0·433714
Magnesium "	0·125291
" iodide	0.000022
" bromide	0·001277
Calcium sulphate	0·092769
Strontium "	0.000024
Barium "	0.000213
Calcium bicarbonate	0·612454
Magnesium "	0·085042
Ferrous "	0·007608
Manganous "	0·001324
Calcium phosphate	0·000245
Aluminum "	0·000193
Silicic acid	0·063167
Calcium borate	trace
" arseniate	"
Cæsium chloride	"
Rubidium chloride	"
	8·408248
Free carbonic acid	·334439
Total solids	8·742687

On the **dissociation of hydrated salts.**—G. Wiedemann.—As early as 1844 Mitscherlich remarked that a crystal of sodium sulphate introduced into the vacuum of a barometer causes the mercury to fall several lines, owing to separation of the chemically combined water. Dr. Wiedemann pushes the subject further, examining the sulphates of magnesia, iron, nickel, with interesting results.

Examination of a churchyard water of Leipzig.—O. Bach.—The table of analysis cannot be here introduced; the author concludes, however, that the proximity and age of the graves has less influence on the nature of the water than the properties of the soil over which it flows.

No. 19.

On the doctrine of **catalytic action.**—G. Häfner.—Second paper on the mechanics of catalysis.

The author in a previous paper showed that so-called catalytic effects may well be referred to variations of the same force which produces ordinary chemical action, and that it is not necessary to call into existence a new (not chemical) force to explain the phenomena alluded to. In the present paper he investigates the mechanics of the forces brought into play, and concludes that the characteristic point in catalytic forces lies in the expansion of the molecule by the chemical force instead of a complete sundering of the atoms composing it.

On the **chemistry of bones.**—Dr. Carl Aeby.

On the solubility and the dissociation of the **acid carbonates of potassium, sodium, and ammonium.**—Dr. H. C. Dibbits.—The acid carbonates of the alkalies are partially decomposed by solution in water, carbonic acid being set free. The evolution of carbonic acid depends not on the pressure of the air, but on the pressure exerted by the carbonic acid gas itself on the solution. Tables of the solubility of the carbonates named are here given from 0° C. to 60° C.

On the **antiseptic properties of salicylic acid** compared with carbolic acid.—Julius Müller, Apothecary in Breslau.—A series of experiments lead the author to the conclusion that salicylic acid acts powerfully in preventing fermentation and putrefaction, and is much stronger than carbolic acid in its action on the so-called "unorganized ferments."

Chemical retrospect for the year 1874.—H. Kölbe.—The distinguished editor and author of this article, thinks that the chemists of the day in their attempts to explain the arrangement of atoms in a molecule, have developed an extravagant and fanciful theoretical chemistry to which he gives the name "lagerungs-chemie." He gives examples of structural formulæ of spodumen and petalite taken from a recent work on chemical mineralogy which bear him out in his criticisms. He considers that chemistry is on the eve of a more solid and substantial system upon which to arrange the rapidly accumulating facts.

To the **memory of Friederich Rochleder.**—Rochleder was born in Vienna, in 1819, and was one of Liebig's distinguished pupils. His researches were largely in connection with vegetable physiology.

Nos. 1 and 2, 1875.

On the **action of salicylic acid in the prevention of fermentation.**—C. Neubauer.—The author declares that in salicylic acid we have an antiseptic of incomparable value. Possessing neither odor nor taste, and being innocuous, it is far preferable to carbolic acid for the preservation of food and drink. The experiments were made with must.

Further communications on the **action of salicylic acid.**—H. Kolbe.—By numerous experiments Prof. Kolbe confirms the announcement previously made by him that the isomeric paraoxybenzoic and oxybenzoic acids

do not share the antiseptic properties of salicylic acid. He quotes a letter from Dr. Fehling, of the Leipzig Gynakological Institute, to the effect that the employment of salicylic acid as a disinfectant (in place of carbolic acid) has led to most favorable results.

On the **preparation of pure paraoxybenzoic acid** by the transformation of salicylic acid.—H. Kolbe.—The best method of converting salicylic acid into paraoxybenzoic acid is found to be the distillation of dry neutral potassic salicylate. This material is heated in a retort to 220°, phenol distils over, and the residue in the retort consists of potassium-paraoxybenzoate of potassium, which may be easily purified by solution in water and precipitation with hydrochloric acid. When sodium salicylate is used instead of potassium, the salicylic acid is not thus transmuted, as shown in the following equation:—

$$\left.\begin{matrix} C_6\{H_4\{COONa\}OH \\ C_6\{H_4\{COONa\}OH \end{matrix}\right\} = C_6\{H_4\{COONa\}ONa + C_6H_5OH + CO_2.$$

On the **quantitative estimation of water.**—H. Laspeyres.—Whenever practicable the determination of water, in minerals and in organic bodies, by *indirect weight*, *i. e.* by loss on ignition, is much to be preferred to the method by direct weight. When, however, the latter method must be employed, great attention should be given to drying the air used to pass through the chloride of calcium tube. It should be borne in mind that air dried by chloride of calcium (whether fused or otherwise is the same), is only relatively dry, and will still yield moisture to concentrated sulphuric acid. The desiccating power of fused chloride of calcium and merely dried chloride of calcium is nearly the same, but to obtain very accurate results, one or the other should be used throughout the apparatus employed. Hence it is recommended to heat the chloride of calcium in an air-bath at 150°–200°, previous to use. The weighings should be made immediately before and after the operation. Other minute points to insure accuracy are given, and numerous analyses fortify them all.

Investigation of "**unformed ferments**" and their action.—G. Hufner.—Third paper. Not suitable for abstraction.

Practical observations on the **action of salicylic acid.**—Dr. W. Wagner.—Salicylic acid replaces perfectly carbolic acid as a disinfectant in bandaging fresh wounds. In venereal abscesses disinfection is insufficient; cauterization is necessary. The author very highly recommends the new antiseptic in many other cases, especially in diphtheria.

Communications from the Laboratory of the Royal Industrial School at Nuremberg.

I. On the **detection of nitrous and nitric acids in water.**—Hermann Kaemmerer.—In a previous publication the author showed that in testing water for nitrous acid with iodide of potassium starch paper, acetic acid only (not sulphuric) should be used; for sulphuric acid sets nitric acid free from the nitrates, and this acid is reduced by the organic matter in the water.

Fresenius, commenting on this, undertook to prove that greater delicacy of reaction was obtained by distilling the water; the present paper is in answer to Fresenius and other critics. Kaemmerer shows that Fresenius's method of distillation actually produces nitrous acid not existing previous to the boiling.

II. On the **quantitative determination of nitric acid, especially in water.**—Friedrich Gramp.—The use of sodium amalgam in alkaline solution is recommended for converting the nitric acid into ammonia.

III. On the **quantitative analysis of cinnabar.**—Friedrich Gramp.—The author determines sulphur in cinnabar by heating with nitric acid in sealed tubes and precipitating the sulphuric acid formed with barium chloride. Nitric acid of sp. gr. 1·4 is used, and a temperature of 120°. In the filtrate the mercury is determined by phosphorous acid. An insoluble residue of calcium sulphate, silica, etc., remains on the filter.

IV. On the **presence of chromium in emery and bolus.**—Hermann Kaemmerer.—Genth's observation of chromium in emery is confirmed.

Notice on the **reaction between cuprous sulphide and argentic nitrate.**—R. Schneider.—The reaction is as follows:—

$$Cu_2S + 2(Ag_2N_2O_6) = 2(CuN_2O_6) + Ag_2S + 2Ag.$$

On **new sulpho-salts.**—R. Schneider. (Concluded.) From Pogg. Ann. 153, 588.—The lengthened investigation of sulpho-salts by Schneider is here brought to a close. The following table includes in its six groups all the salts named in this and previous papers.

First group.	Second group.	Third group.
Na_2SPdS_2	K_2S2HgS	K_2S_3ZnS
	Na_2S2MnS	Na_2S_3ZnS
		Na_2S_3CdS

Fourth group.	Fifth group.
$K_2SFe_2S_3$	$Na_2SFe_2S.FeS_2$
$Ag_2SFe_2S_3$	$K_2SNi_2S.NiS_2$
$K_2STl_2S_3$	$K_2SPd_2S.PdS_2$
$K_2SIn_2S_3$	$Ag_2SPd_2S.PdS_2$
$Na_2SIn_2S_3$	
$K_2SBi_2S_3$	
$Na_2SBi_2S_3$	

Sixth group.

$K_2S,Cu_2S,Cu_2S,Cu_2S.Cu_2S_2$
$Na_2S,Na_2S,Cu_2S,Cu_2S.Cu_2S_2$
$K_2S,PtS,PtS,PtS.SnS_2$
$Na_2S,PtS,PtS,PtS.SnS_2$
$K_2S,PtS,PtS,PtS.PtS_2$
$Na_2S,PtS,PtS,PtS.PtS_2$
$Na_2S,Na_2S,PtS,PtS.PtS_2$
$Ag_2S,Ag_2S,PtS,PtS.PtS_2$
$Tl_2S,Tl_2S,PtS,PtS.PtS_2$
$CuS,CuS,PtS,PtS.PtS_2$
$PbS,PbS,PtS,PtS.PtS_2$
$PtS,PtS,PtS,PtS.SnS_2$
$PtS,PtS,PtS,PtS.PtS_2$.

H. C. B.

Les Comptes Rendus de l'Académie des Sciences.

Vol. lxxix., No. 14.

Report on a **refrigerating machine**, by the vaporization of methylic ether, invented by Ch. Tellier; and on the preservation of food in air cooled by this apparatus.—Edwards, Peligot, Bouley.—This machine consists of five parts—

1st. The chamber of the refrigerator, of large capacity and transversed by a large number of tubes.

2d. A pump to send the liquid which is to be frozen into the tubes.

3d. A reservoir for the cooling liquid from which it is distributed in all directions.

4th. A compressing pump.

5th. A condenser in which the methylic ether, having been vaporized in the tubes, resumes the liquid form under pressure of eight atmospheres. The liquid used to transmit the cold into the apparatus is a solution of chloride of calcium. This apparatus is further described at great length, together with various trials made with the apparatus.

Researches on **explosive substances.**—Roux and Sarrau.

1st. The authors have shown in a preceding communication how two different explosions may be obtained with dynamite, one by ordinary inflammation, and the other, detonation, by strong percussion or fulminate of mercury.

Recent experiments at the central powder depot, show that this remarkable property of dyamite belongs to almost all explosive substances.

2d. (1°.) Nitro-glycerin, pyroxylin, picric acid, picrates of potash, baryta, strontia, and lead, detonate by fulminate of mercury, whereas fired with one of Abel's capsules or a small quantity of powder, they produce an explosion of the second order.

(2°.) Powder in grains or dust does not detonate by fulminate of mercury, but if nitro-glycerin, itself fired by fulminate, be employed as an auxiliary detonator, an explosion of the first order is obtained very different from the ordinary explosion of powder with which we are familiar.

(3°.) The explosion of fulminate of mercury by the Abel priming appears to be of the first order, while it gives, under conditions which it has been impossible to fix with precision, a less violent explosion corresponding to one of the second order.

3d. These results have been obtained by finding the charges necessary to burst small shells of the same resistance. The error is estimated not to exceed $\frac{1}{40}$, and this is sufficiently accurate for this purpose.

4th. Details of some of the experiments.

5th. The following table gives also the quantity of permanent gases furnished, and the quantity of heat disengaged by one kilogramme of each substance. The calorimetric determinations are less accurate for detonation than for simple explosion. In the first place it is necessary to operate on small quantities of the substance on account of the intensity of the effects produced, and then the heat includes that of the detonator, and cannot be very accurately corrected.

Name.	Explosive force.		Weight of gas	Heat disengaged.	
	2d order.	1st order.	2d order.	2d order.	1st order.
				cal.	cal.
Sublimate of mercury		9·28			752
Powder B . . .	1·00	4·34	0·414	731	732
Nitro-glycerin . .	4·80	10·13	0·800	1720	1777
Pyroxylin . . .	3·00	6·46	0·850	1056	1060
Picric acid . . .	2·04	5·50	0·892	828	868
Picrate of potash .	1·82	5·31	0·740	787	852
Picrate of baryta .	1·71	5·50	0·719	671	705
Picrate of strotia .	1·35	4·51	0 624	637	745
Picrate of lead . .	1·55	5·94	0·668	555	663

6th. The results of this table may be verified by Berthelot's rule that the simple explosion of a substance is proportional in force to the product of the weight of gases by the heat. The force of detonation is very nearly proportional to the heat of combustion for six of the substances studied. Fulminate of mercury and the picrates of baryta and lead do not satisfy this rule, which, nevertheless, we believe sufficiently applicable to substances which do not contain metallic elements.

7th. Detonation requires a certain proportion between the mass of the detonating body and the detonator, and in this respect explosive bodies are divided into two classes, one detonating throughout its whole extent when only a single point is submitted to the detonating influence, the other requiring the detonating influence to be exerted on all parts of the mass. The authors propose to return to this point.

On the **synthesis of purpurine and analogous** coloring matters.—A. Rosenstiehl.—MM. Schutzenberger and Schiffert, in the analysis of commercial purpurine, have found a small quantity of a yellow substance, imperfectly dyeing alumina mordants an orange-yellow, and having the composition of alizarine or a hydrate of alizarine. M. Schutzenberger has moreover observed that this substance, which he calls purpuroxanthine, is produced by reducing purpurine either by iodhydric acid or by oxide of tin in an alkaline solution.

1st. Purpuroxanthine is easily prepared by making oxide of phosphorus act warm on an alkaline solution of purpurine. The reduction is soon accomplished. The precipitate is washed and dried. It sublimes in orange-yellow crystals, dissolves in alcohol, acetic acid, and benzene; water precipitates it from its alcoholic solution, the alkalies dissolve it with a red color. It dissolves in hot alum solution, but separates on cooling. It does not dye mordants of alumina and iron. Analysis gives its formula $C_{14}H_8O_4$. It is, then, an isomer of alizarine, and probably identical with the alizarine of Rochleder.

2d. In an alkaline medium, reducing agents do not modify it permanently; it changes red to brown, but is restored by acidulated water. Treating it with boiling acid at 127° and white phosphorus at the ordinary pressure, a yellow coloring-matter is obtained, greener than the preceding, separating out in brilliant crystals from iodhydric acid, alcohol, acetic acid, and benzene. It does not sublime. Its alkaline solution is brown and oxidizes on exposure to the air, reforming purpuroxanthine. Analysis gives $C_{14}H_{12}O_4$ or $C_{14}H_{10}O_4$ for its formula. By prolonging the action of iodhydric acid under the conditions indicated, anthracene and its two hydrides are obtained. Phenanthrene has not been found among the products of this reduction. Heated with powdered zinc, purpuroxanthine yields anthracene.

3d. In a boiling alkaline solution an atom of oxygen attaches itself to purpuroxanthine, and purpurine is reformed. It is identical with that of the madder. The synthesis of purpurine is thus brought to an isomer of alizarine, affording a second solution of the problem of the industrial production of this precious body.

4th. The author has repeated the synthetical experiments of M. de Lalande, and obtained a purpurine identical with that of the madder and with that which he obtained from purpuroxanthine. This artificial purpurine obtained by oxidation from alizarine, gives not alizarine but purpuroxanthine, and from this purpurine can be reformed. It would appear, then, that there are three hydroxyl radicals, one of which characterizes alizarine, a second, purpuroxanthine, and the third, common to both isomers.

5th. The author has tried the effect of alkaline solutions on two other isomers of alizarine, chrysophanic acid, and anthraflavone. The first of these gives an isomer of purpurine, and the second, which much resembles purpuroxanthine, gives a substance which, on analysis, resolves into two coloring matters resembling alizarine and purpurine, but differing from them in their solubilities.

6th. The author speaks of a fifth isomer of alizarine, chinizarine. He supposes these isomers to differ from each other in different positions of the group (HO), and points out two general classes, in one of which all the (HO) are contained in one group C_6 of anthraquinone (C_6H_4CO,C_6H_4), and in the other, are divided between the two. To the first class belong pseudo-purpurine, $C_6H_4O_3,C_6(HO)_4$, purpurine, $C_6H_4O_2,C_6H(HO)_3$, alizarine and purpuroxanthine, $C_6H_4O,C_6H_2(HO)_2$, for all these bodies produce by oxidation phthalic acid, which contains (C_6H_4) intact. To this class belongs chinizarine, obtained by the action of phthalic acid on hydroquinone. To the second class belong—

(1st.) Anthraflavone, obtained from two molecules of oxybenzoic acid by the elimination of water—

$2C_6H_3(HO),COHO - 2H_2O = C_6H_3(HO),CO,CO,C_6H_3(HO)$.

(2d.) Anthrachrysone, from dioxybenzoic acid—

$C_6H_2(HO)_2,C_2O_2,C_6H_2(HO)_2$.

(3d.) Rufiopine, obtained from ossianic acid by MM. Liebermann and Chojnacki, and

(4th.) Rufigallic acid, from trioxybenzoic or gallic acid,

$C_6H(HO)_3,C_2O_2,C_6H(HO)_3$.

In order that a derivative of anthraquinone should be a coloring matter, it is necessary that the same group, O_6H_4, should contain two atoms of the radical (HO), but this condition is not sufficient, since of the five isomers of alizarine, only it and chinizarine dye mordants; but when three atoms of hydrogen are replaced, we have purpurine, $C_6H_4,C_2O_2,C_6H(HO)_3$, and rufigallic acid $C_6H(HO)_3,C_2O_2,C_6H(HO)_3$, etc., are produced, whose colors resist the action of soap.

New observations on the subject of the chemical composition of the **waters of Bagneres-de-Luchon.**—E. Filhol.—The author has not been able to obtain from the mineral water desulphurized by carbonate of lead, any more carbonic acid than from ordinary water. He maintains that this water, desulphurized by sulphate of lead pure and filtered, is slightly alkaline. Titrated with sulphuric acid, it requires 0·1030 gr. sulphuric acid to neutralize it. The alkalinity is due in part to sulphur compounds, and in part to carbonates and silicates which accompany them, 0·0735 gr. acid for 0·0717 gr. monosulphide of sodium, and 0·0295 acid neutralized by the silicates or carbonates. The author goes on to show that the figures of that note are incorrect, since 0·0717 gr. of the monosulphide, or 0·0514 of the sulphydrate could not give 0·1071 gr. sulphuric acid by double decomposition with sulphate of lead. This quantity of sulphuric acid represents 0·0428 gr. of sulphur, not 0·0294, and 0·1044 gr. monosulphide instead of 0·0717.

The author regards the following as the reaction that takes place:—

$$2NaS + 2(PbSO_4) = 2PbS + 2(NaSO_4),$$

Or in case of the sulphydrate—

$$NaSHS + 2(PbSO_4) = 2PbS + NaSO_4 + H_2SO_4.$$

Volumetric estimation of copper.—Pr. Lagrange.

1st. Precipitation of the copper from sulphuric or nitric acid solution by caustic soda or potash.

2d. Transformation of the hydrate obtained into cupropotassic or sodic tartrate.

3d. Reduction of the copper salt to protoxide by a standard solution of pure glucose.

Spectro-electric tube for observing the spectra of metallic solutions.—B. Delachanal and A. Mermet.

The **action of bromine on certain alcohols.**—E. Hardy.—Loewig, in 1832, recognized bromal as one of the products of the action of bromine on alcohol. Schaeffer afterwards prepared it by a method simpler than that of Loewig. In both cases a number of secondary products are formed, and the reaction is difficult to understand. It may be expressed in two parts as follows:—

$$3(C_2H_6O) + 8Br = \underset{\text{Bromhydric ether.}}{C_2H_5Br} + \underset{\text{Alcoholate of bromal.}}{C_2HBr_3O,C_2H_6O} + 4HBr + H_2O.$$

$$2(CrH_6O) + 8Br = \underset{\text{Bromhydric ether.}}{CrH_5Br} + \underset{\text{Bromal.}}{C_2HBr_3O} + 4HBr + H_2O.$$

These substances can be separated by distillation. A similar reaction takes place with the higher alcohols.

Propylic Alcohol.—

$$3(C_3H_8O) + 8Br = \underset{\text{Propylbromhydric ether.}}{C_3H_7Br} + \underset{\text{Propylalcoholate of propylbromal.}}{C_3H_8O,C_3H_3Br_3O} + 4HBr + H_2O.$$

Propylalcholate of propylbromal is a slightly yellowish liquid, giving the following proportions by analysis:—

	I.	II.	III.	IV.	V.	Calculated.
C	21·9	22·5	21·1	"	"	20·3
H	3·0	3·0	"	"	"	3·0
Br	"	"	"	68·4	67·9	67·6

Butylic Alcohol.—Under similar circumstances butylic alcohol gives butylbromhydric ether, butylalcoholate of butylbromal, and a non-volatile residue which carbonizes on elevating the temperature. Butylalcoholate of bromal gave on analysis—

	I.	II.	Calculated.
C . .	26·4	"	27·6
H . .	"	"	3·9
Br . .	"	62.8	62·6

Giving $C_4H_5Br_3O,C_4H_{10}O$.

Amylbromal.—This is formed in a similar way from amyl alcohol.

Note on the production of **oxamic acid** by the oxidation of glycocol.—R. Engel.—The author has succeeded in producing oxamic acid, $\begin{matrix}CO_2NH_2\\COOH,\end{matrix}$ from glycol, $\begin{matrix}CH_2NH_2\\COOH,\end{matrix}$ by oxidation with permanganate of potash. After freeing the solution from oxalic and carbonic acids by means of chloride of calcium, the basic oxamate of lead was obtained by treating the solution with subacetate of lead. Ammonia gives in concentrated solutions of oxamic acid a white crystalline precipitate of oxamate of ammonia, very slightly soluble in water. The author suggests that glycocol in the blood may in the same way be transformed into oxamic acid by the biliary acids, and afterwards into oxalic acid. The author proposes to take up hereafter the further products of the oxidation of oxamic acid.

Action of heat on the isomeric hydrocarbons **diphenylmethane and phenyltoluene.** The products of reduction of benzophenone. — Ph. Barbier. — The author has attempted to accomplish the synthesis of fluorene $C_{26}H_{10}$ by taking H_2 from $C_{16}H_{12}$, but there are several isomers $C_{16}H_{12}$, *e. g.*—

Diphenylmethane, $C_{12}H_4,C_2H_2[C_{12}H_6] = C_{26}H_{12}$.

Phenyltoluene, $C_2H_2,C_{12}H_4[C_{14}H_6] = C_{26}H_{12}$.

He prepared the latter by the action of sodium on a mixture of bromide of benzene and bromide of toluene.

Action of Heat on Diphenylmethane.—Heated for five minutes in a closed tube, it gives anthracene and a mixture of benzene and toluene.

$$2C_{26}H_{12} = C_{28}H_{10} + 2C_{12}H_6 + H_2$$

is the principal reaction, and

$$C_{26}H_{12} + H_2 = C_{12}H_6 + C_{14}H_8$$

is a secondary reaction which takes place at the same time. A small quantity of phenanthrene was formed, but fluorene was not observed.

Action of Heat on Phenyltoluene.—Benzene and toluene are reformed, but no anthracene is produced. The product of the reaction is a thick liquid boiling at 300°, which the author has not thoroughly studied.

Reduction of Benzophenone by the Action of Powdered Zinc.—The product of this reaction is a liquid which does not crystallize, and which, after being rectified several times over sodium, boils at 269-270° (temperature corrected). It is somewhat similar to diphenylmethane, but not only does analysis show that it is not that—

	I.	II.	$C_{28}H_{14}$	$C_{26}H_{12}$
C	91.96	91·98	92·3	92·8
H	7.25	7·39	7·7	7·2

but when heated to 500° in a closed vessel it gives

neither anthracene nor benzene, and only a small quantity of toluene. Here, as in the case of phenyltoluene, no fluorene is formed.

No. 15.

Determination of the proportion of the **real ash** to the **sulphate residue** in the products of the **sugar industry**.—Ch. Viollette.—The coefficient 0·9 commonly used in the analysis of sugars is too high, and should be replaced by 0·8 and even 0·7 for very pure sugars.

Microscopic study and analysis of a **pumice stone from Vesuvius**.—F. Fonqué.—In its outward appearance it resembled ordinary specimens, but by the aid of the microscope it is seen to consist of a multitude of crystals united by an amorphous vitreous mass. The crystals are principally Vesuvianite, with crystals of several other substances distributed irregularly through the mass.

200 grammes of the pumice stone furnished as follows:—

	Gr.
Pyroxene	1·100
Hornblende	0·340
Feldspar	0·120
Oxide of iron	0·070
Magnesian mica	0·012
Peridote	0·025

No. 17.

On the **fermentation of apples and pears**.—Lechartier and Bellamy.—(Not suitable for abstraction.)

Absorption of gas by the iron wire heated red hot and plunged in dilute sulphuric acid during the operation of drawing wire.—D. Sevoz.—This gas is given off on afterward dipping the wire in water, and the question arises whether it is carbonic oxide absorbed by the iron during the heating, or hydrogen dissolved by the metal during the treatment with sulphuric acid, and much compressed by the operation of drawing the wire. It forms an explosive mixture with air, and seems to impart to wire its brittleness.

On the **isomerism of perbromide of acetylene and tetrabromide of ethylene hydride**. — E. Bourgoin.

Tetrabromide of Ethylene Hydride.—After the preparation of this substance by the action of bromine at 170° on bibromosuccinic acid in the presence of water, it remains liquid for a long time, owing to the presence of a small quantity of secondary products. Left to itself, it would crystallize at once. It crystallizes in beautiful needles sometimes several centimetres in length. It is insoluble in water, somewhat soluble in absolute alcohol, and quite so in ether. To obtain perfect crystals a mixture of alcohol and ether is used.

Perbromide of Acetylene.—This was prepared by conducting acetylene into bromine under water at about 50°. The addition of crystals of tetrabromide of ethylene hydride does not determine the crystallization of the mass. With the view of obtaining a different product the author caused acetylene to act on bromine in the state of vapor. The action was very violent, and much heat was disengaged. Three products were obtained: 1st, perbromide of acetylene, the principal product; 2d, a new body resulting from the action of bromine on the preceding; 3d, a small quantity of crystalline matter which separated out on subjecting the mixture to a temperature of 20°. This last body differs from the tetrabromide, but from the resemblance, properties, etc., the author concludes the latter to be isomeric with perbromide of acetylene. He regards the difference between them as analogous to that between the oil of the Dutch chemists and chlorhydric ether.

Researches on the **decomposition of certain salts by water**.—A. Ditte.

II. Nitrate of bismuth, $BiO_3,3NO_5,3HO$. This is decomposed by the addition of water with the formation of a white crystalline precipitate, BiO_3,NO_5, subnitrate of bismuth. On gradually adding free nitric acid, however, a point is reached beyond which the nitrate is not decomposed. A curve may be drawn to represent the solubility of this nitrate. This curve is regular until the abscissa corresponding to 83 gr. per litre is passed; beyond that, the quantities of oxide of bisumth do not increase with the same rapidity. When 83 grammes to the litre of free acid is present, decomposition no longer takes place, but the neutral salt simply dissolves. This amount of free acid, it will be found, varies somewhat with the temperature.

III. Subnitrate of bismuth, BiO_3,NO_5,NO. This is also decomposed by water into free acid, and a more basic salt, $2BiO_3,NO_5$. This accounts for the differences in composition presented by the subnitrate of bismuth of commerce. The amount of free acid requisite for the solution of the subnitrate without decomposition is 4·5 grammes to the litre.

IV. Protochloride of antimony, Sb_2Cl_3. This salt is decomposed by water into free hydrochloric acid and oxychloride of antimony, Sb_2O_2Cl. 159 gr. hydrochloric acid to the litre is required to make it dissolve without decomposition. Oxychloride of antimony, also, is decomposed like subnitrate of bismuth. In the cold this action is hardly appreciable, but at 100° the quantity of free acid liberated is considerable.

No. 18.

Note on a modification of the Fehling and Barreswil solutions, used for the **determination of glucose**.—P. Lagrange.—The difficulty with these reagents is their want of stability. The quantity of alkali to be added in proportion to the neutral tartrate of copper is a very important point. If too little is added, the reagent decomposes, if too much, it has an action on crystallizable sugars which introduces errors.

The author recommends the following proportions:—

Dry neutral tartrate of copper	10 gr.
Pure caustic soda	400 "
Distilled water	500 c.c.

The tartrate of copper is obtained by decomposing the sulphate of copper by neutral tartrate of soda, or the reagent may be prepared from the double tartrate of copper and soda.

On the **fermentation of fruits**.—G. Lechartier and F. Bellamy.—Note in a previous number on the fermentation of apples and pears, extended to other fruits, *e. g.* cherries, currants, figs, limes, etc. etc. (Not suitable for abstraction.) J. M. M.

The Chemical News.

No. 788.

On the **effect of heat on iodide of silver**. (Final Paper.)—G. F. Rodwell.—From a series of experiments, the author concludes:—

1. That iodide of silver exists in three allotropic forms, viz.: (*α*) between 116° C. and its fusing point, as a reddish, transparent, plastic, amorphous substance; (*β*) below 116° C. as a brittle, opaque, greenish-gray, crystalline mass; and (*γ*) if fused and poured into cold water, as a very brittle, yellow, and opaque substance.

2. Its maximum density occurs at or about 116° C.

3. If we allow the molten iodide to cool, we observe: (*α*) at the moment of solidification it considerably contracts till 116° C. is reached, when it violently expands.

No. 789.

On the **distillation of ammonia in presence of sulphocyanides.**—A. Esilman.—In estimating ammonia by distillation with caustic alkali it was found that the India-rubber tubing absorbed the ammonia.

When sulphocyanides were present, they were decomposed when caustic soda was employed, but were not affected by caustic lime or magnesia. He recommends lime, as magnesia, from its insolubility, is slow in its action.

No. 791.

On a **simple apparatus for estimating urea.**—R. Apjohn.—The author uses:—

1. A glass tube, one foot long, subdivided into 30 equal parts, whose aggregate volume is 55 c. c. One end of the tube is drawn like a Mohr's burette.

2. A wide-mouthed gas bottle of 60 c. c. capacity.

3. A test-tube of 10 c. c. capacity and long enough to be slightly inclined when introduced into the gas bottle.

Into a glass cylinder containing water the tube (1) is depressed till the zero mark and surface of water coincide. 15 c. c. hypobromite solution (100 grms. NaHO, 250 c. c. H_2O, 25 c. c. Br) are placed in (2) and the test-tube containing the urine is introduced carefully to avoid spilling its contents. The flask is closed by a perforated stopper which is connected by tubing with the measuring tube. The urine is now mixed with the hypobromite, and the disengaged nitrogen is driven into the measuring tube. The tube is now levelled to relieve hydrostatic pressure, and the volume of nitrogen read off. Since 55 c. c. equal 0·15 grm. of urea, a single division corresponds to $-\frac{0{\cdot}15}{30} = 0{\cdot}005$ grm. urea.

No. 792.

A study of **condensation radicals.**—S. E. Phillips.

No. 793.

Some points in the **chemistry of milk.**—C. A. Cameron.—From several thousand analyses of cow's milk, the author concludes that the mixed milk of town cows never contains less than 12, and that of country cows 11·5 per cent. of solids.

Of the following analyses (1) is the average of forty analyses of pure milk from Dublin dairy cows; (2) of the analyses of the milk of fourteen mares, and (3) of two analyses of sow's milk.

	1.	2.	3.
Water	87·00	90·310	81·760
Fats	4·00	1·055	5·830
Albumenoids	4·10	1·953	6·180
Sugar	4·28	6·285	5·335
Mineral matters	0·62	0·397	0·895
	100·00	100·00	100·00

The color of (2) is bluish-white, of (3) yellowish-white.

The sp. gr. of (2) is 1·031, of (3) 1·041.

On the water-bath (3) exhales the odor of roast pork.

No. 794.

On the use of **stannous chloride as a reducing agent in the technical assay of iron ores, etc.**—W. F. K. Stock and W. E. Jack.—The authors find that by this method the reduction is effected in ten minutes. They bring 1 grm. of ore into solution, directly or by fusion with alkaline carbonate, dilute to 500 c. c. with distilled water, and boil; stannous chloride is added in small portions till a drop of the solution gives only a faint coloration with potassic sulphocyanate. The solution is titrated with potassium bichromate (standard solution) as usual. By this way (1) 0·3120 grm. annealed iron wire gave with potassium bichromate 0·3120 grm. iron.

(2) 0·3470 grm. wire gave 0·3369 grm. iron.

(3) 0·3650 grm. wire gave 0·36589 grm. iron.

No. 795.

Observations on the **production of nitrous ether by means of sulphuric acid.**—T. L. Phipson.—The author, in following the method of M. Champion, found that *nitric* ether is formed, not in the course of half an hour, but in the space of a few minutes only; and that suddenly the whole decomposes with production of great heat, and increases to twelve or fourteen times its original volume. He concludes that, if produced in large quantities, it would probably have very serious consequences.

On a new process of **preserving wood from fire and decay.**—S. W. Moore.—The wood is dried; treated with lime-water, saturated with sulphurous acid gas under pressure by which sulphate of lime is formed in the pores of the wood. The sp. gr. of the wood thus prepared is less than that of the original.

On a new method of **quantitative analysis of ordinary alloys.**—S. Kern.—Founded on the law that metallic salts are reduced by metals. Silver alloys dissolved in nitric acid and the silver reduced by copper. Lead alloys containing tin are dissolved in nitric, those containing antimony in hydrochloric acid. Zinc is used to reduce tin in the former, and antimony in the latter.

Copper alloys have the copper reduced by iron.

E. H. W.

Archiv der Pharmacie.

June, 1874.

Contributions from the University Laboratory at Erlangen.—Dr. A. Hilger.

I. **Amylnitrite.**—The writer obtains the best results by conducting HNO_2, prepared by the action of HNO_3 on As_2O_3, into chemically pure amylalcohol at a temperature from 70° to 90° C. The product is treated with dilute caustic potash or magnesia, and deprived of H_2O by $CaCl_2$. Finally it is distilled over magnesia and $CaCl_2$, and the portion which passes over between 90° and 95° is free from acid, of a pale-yellow color, and of a specific gravity ·902 to ·9026.

Amylnitrite, thus obtained, undergoes decomposition in a few months, when exposed occasionally to access of air and moisture, and gives rise to nitrous, nitric, valerianic, and hydrocyanic acid along with valerianate of amyl and amylalcohol.

II. **Mercury oleate.**—This compound is said to be used now in all cases in which unguentum hydrargyri cinereum was employed. It is prepared by dissolving freshly precipitated and dried mercuric oxide in oleic acid at a temperature from 60° to 70° C. 5% of HgO gives a clear yellow liquid; 10% gives also a liquid; but 20% produces a salve-like mass. The addition of a little palmitic or stearic acid gives more consistency and permanency to the compound, without injuring in any degree its therapeutic value.

III.—**Analysis of illuminating gas prepared from paraffine oil.**

C_2H_4	28·91
CH_4	54·92
H	5·65
CO	8·94
CO_2	·82

IV.—**Mineral analyses.**

a.—*Variegated copper ore* from a mine near Willichen in Schwarzewold.

S	23·95
Cu	64·03
Fe	11·31
	99·29

b.—*Oligoclase* from granite of the Fichtelrange.

SiO_2	61·36
Al_2O_3	22·25
Fe_2O_3	1·60
CaO	1·10
MgO	trace
Na_2O	11·06
K_2O	2·07
	99·44

c.—*Soda orthoclase* from gneiss at Wolfach in Schwarzwold.

SiO_2	68·18
Al_2O_3	16·60
Fe_2O_3	·45
CaO	3·70
MgO	1·38
Na_2O	4·70
K_2O	5·81
	100·82

d.—*Basalt* from Weilburg in Nassau.

SiO_2	41·33
Al_2O_3	18 31
Fe_2O_3	8·52
FeO	6·10
CaO	11·76
MgO	8·40
K_2O	1·01
Na_2O	2·34
H_2O	1·63
	99·40

Adulterated linseed meal.—A. Vigener.—Linseed oil cake is used in certain parts of Germany for fattening cattle, and particularly as food for milch cows. A case occurred in which, after feeding, symptoms of poisoning ensued, loss of strength, and a wonderful shrinkage of milk, in some cases, six or seven quarts a day. By careful examination, microscopical and otherwise, the cake was found to be largely adulterated with castor-bean meal, which was supposed to be the cause of the trouble. Castor-bean meal is well known to produce vomiting, purging, headache, loss of appetite, and other disagreeable symptoms, and sometimes even death. Prussic acid was detected in the extract from the cake, formed probably by the decomposition of the amygdalin of the castor bean.

Syrupus amygdalarum siccatus.—Dr. Enders.—Syrup of almonds soon becomes chemically changed and worthless. The author recommends the preparation of a powder after the manner of condensed milk. For this purpose he crushes 20 parts of sweet almonds in distilled water, extracts the emulsion as perfectly as possible, then adds to it 72 parts of sugar and evaporates the whole rapidly to dryness. The residue, amounting to 82 parts, is reduced to a powder and preserved in a closely corked flask. To prepare the syrup, add to these 82 parts, 4 parts of aq. amygdali, 6 parts of aq. flor. aurant., and 25 parts of distilled water.

Detection of morphine in presence of quinine.—L. W. Jassoy.—Treat sulphate of quinine with 20 times its weight of water. If sulphate or chloride of morphine is present, it will be in part dissolved. Filter and treat the filtrate with iodic acid. Iodine will be set free, imparting a yellow or brown color to the liquid. If chloroform be added, the iodine will be dissolved with violet color.

If the chloride of quinine contain a morphine salt, and be treated in the same way, more quinine will be dissolved than if it were sulphate. In this case also iodic acid will be reduced, but the iodine does not give a violet color with chloroform. Several alkaloids besides morphine give similar results.

Extractum ligni Campeachiani.—C. Schneider.—This extract, used much in the manufacture of ink, often contains from 37 to 40% of a resinous substance, which is dissolved with great difficulty. This difficultly soluble substance, the author thinks, is produced by the long boiling in the preparation, and he recommends the concentration of the extract in a vacuum pan, at a temperature from 35° to 40° C.

Small items.—Dr. A. Aé.

(1). **A preparation for coloring hair,** called Teinture de Venus du Dr. Louis Bonnot, was found to consist of water, alcohol, glycerine, milk of sulphur, and about 5% of sugar of lead.

(2). **The disinfection powder of Lueder and Leidhoff** contains 4% of oil of vitriol, 16% of anhydrous sulphate of protoxide of iron, 36% of sulphate of sesquioxide of iron and gypsum. It killed divers ducks and geese that frequented pools and gutters where it was used.

(3). **Bland's pills** are made thus: 15 parts of pulverized sulphate of iron, 15 of carbonate of potash, and 3 of powdered sugar, all ground together. 33 parts of this mixture are mixed with 6 parts of althea powder.

Rapid distillation of ether from extracts.—Dr. G. Vulpius.—The end of the short arm of a siphon is placed and kept about a centimetre above the surface of the ethereal solution, while that of the larger arm extends to a much lower level. By sucking through and filling the tube with the vapor of ether, the vapor will then continue to flow so rapidly in a summer temperature as to fall in drops from the long arm of the siphon.

A. P. S. S.

Pharmaceutische Zeitschrift für Russland.

Vol. xiii. No. 15.

The tartrates and citrates of iron, and their ammoniacal compounds.—C. Mehu.—The main object of the investigation was to find a method of preparing a ferrous tartrate, and a ferric ammonic tartrate and citrate of constant and stable composition. The ferrous tartrate was made by boiling fine iron wire with a solution of tartaric acid, filtering out the sandy precipitate that was formed, washing it most carefully with hot water, and drying it rapidly in a warm chamber. The product thus obtained shows no tendency to oxidize when dry. Ammonio-ferric tartrate was readily prepared from this salt by dissolving it, best while still moist, in ammonia water, and allowing the solution to oxidize in the air, and to evaporate spontaneously in shallow dishes. The residue is not deliquescent, is very soluble in water, but insoluble in alcohol and ether.

Nos. 16 and 17.

Same continued.—The author prepared ferrous citrate in the same manner as the tartrate, by boiling together about equal weights of small nails or fine iron wire, citric acid, and water, and obtained the salt as a white sandy crystalline product, somewhat more prone

to oxidize than the tartrate. This salt furnishes a ready means of making the ammonio-ferric citrate, as it dissolves easily in ammonia, especially while still moist; the solution oxidizes readily on exposure to the air for a couple of days in shallow vessels, and on evaporation to dryness leaves a residue of constant composition that is easily kept. This salt is only slightly soluble in alcohol of 85 per cent., and is soluble in water in all proportions.

Vol. xiv. No. 2.

A new property of glycerine.—R. Godeffroy.—A sample of glycerine heated to 150° C. in an open dish took fire and burned with a non-luminous and odorless flame, and left no residue. Other commercial samples left more or less of a residue on burning, but no odor of acroleine is evolved. If a lamp-wick is saturated with glycerine, the latter burns with a non-luminous flame of good heating power. G. C. C.

Journal für Landwirthschrift.

April to June, 1874.

Assimilative power of different individuals of the same age and race compared.—H. Weiske.—Results of experiments with sheep proved that different animals of the same age, race, and herd will assimilate notably different proportions of the same rations, and that the animal with greatest assimilative power will not necessarily produce the greatest increase of weight.

Preparation of acid potassic phosphate for use as a fertilizer in experiments with plants.—B. Tollens.—The author gets a larger yield of crystals, and avoids the formation of a syrupy liquid that will not crystallize readily, by neutralizing a quantity of a solution of phosphoric acid, whose strength is known approximately, with potash, adding half as much phosphoric acid as was used in the first place, and then evaporating and crystallizing. G. C. C.

Bulletin de la Société Industrielle de Mulhouse.

October, 1874.

Memoir on organic sulphides presented to the Society.—E. Croissant and L. Bretonniere.—Extracts of dye-woods on being heated to about 250° afford interesting products, capable of affording very permanent dyes. With other substances, as sawdust, bran, etc., similar dyes of great tinctorial power may be formed by heating with sulphur or an alkaline sulphide to the same temperature. In certain cases the sulphur enters directly into combination with the organic substance. A moderate heat (100°-120°) is then sufficient to produce the transformation.

In most other cases, however, hydrogen in the organic substance is replaced to some extent by sulphur, sulphydric acid being evolved at the same time. A temperature of 250° to 300° is necessary to effect this change. The more elevated the temperature and the more prolonged the heating, the darker the color produced by the product, the more soluble the dye, and the faster the shades produced by it. The product is usually very hygroscopic.

Freshly made and dissolved the dyes readily fix themselves upon the goods without mordants.

Calcareous waters cannot be used with these dyes. Metallic salts precipitate them from their solutions, modifying their shades at the same time. Potassic bichromate is especially mentioned in this connection. It is suggested that the sulphydric acid developed in making these dyes might be collected, and used for various purposes in the arts.

In using these dyes, three baths may be employed with advantage. The first, the solution of the dye or *coloring bath*; the second, a solution of potassic bichromate or *oxidizing bath*; the third, a solution (boiling) of sodic carbonate or *fixing bath*. They may also be employed in printing. The mode of preparing these substances from humus, bran, sawdust, etc. is described, and samples of the dyes on cotton are given.

November.

Note on the **synthesis of purpurine.**—M. Lalande.—By treating one part artificial alizarine with 8 to 10 parts of concentrated sulphuric acid, and one part of arsenic acid or manganese dioxide, and heating gradually to 150° or 160° until a drop of the mixture gave with sodic hydrate the red coloration of purpurine, and then pouring the mixture into a large quantity of water, washing the precipitate formed, and purifying by dissolving in a solution of alum and precipitating by an acid, purpurine was obtained, yielding the following results on elementary analysis:—

	I.	II.	Calculated for $C_{14}H_8O_5$.
Carbon .	65·40	65·40	65.62
Hydrogen .	3·60	3·28	3·13
Oxygen .	——	——	31·25

Additional note on the same subject.—M. Lalande.—By causing methylnitrate to act on alizarine for several hours at 100°, a body identical with Strecker's nitropurpurine, $C_{14}H_7(NO_2)O_5$ is formed. This body was also found to be identical with nitroxyalizarine. The action of nitric acid on alizarine appears to have two phases, first the transformation into purpurine, and next the formation of a nitro-substitution product. The author proposes to investigate the question, whether purpurine is not really trioxyanthraquinone. E. W.

BOOKS RECEIVED.

Transactions of the American Institute of Mining Engineers, vol. ii. May, 1873, to February, 1874.

This volume contains the papers and discussions at the meetings of the Society for the year above mentioned. The papers of most interest to the readers of this journal are: Treatment of Gold and Silver Ores by Wet Crushing and Pan Amalgamation without roasting, by J. M. Adams; the direct Process in Iron Manufacture, by T. S. Blair; Utilization of Blast-Furnace Slags, by J. J. Bodmer; the Wyandotte Silver Works, by W. M. Curtis; the Determination of Sulphur in Iron and Steel, by T. M. Drown (this journal, vol. iv. p. 423); Analysis of Furnace Gases, by T. Egleston (this journal, vol. iv. p. 363); Economical Results of Smelting in Utah, by E. Daggett; Tests of Steel, by A. L. Holley; The Coals of Hocking Valley, Ohio, by T. Sterry Hunt, Lead and Silver Smelting in Chicago, by J. L. Janegan; the Mount Lincoln Smelting Works of Colorado, by E. D. Peters, Jr.; the Calorific Value of Western Lignites, by R. W. Raymond; Alabama Coal and Iron, by R. P. Rothwell; and the Manufacture of Bessemer Pig Metal, by T. F. Wetherbee.

This volume shows the Society of Mining Engineers to be in a flourishing condition and actively at work. We know of no proceedings of any similar society in this country or in Europe which will compare with it as to the number or value of its papers. There is not a single paper in the volume which is not valuable. The work is printed in clear, legible type, and illustrated by several plates at the end of the volume. F. P.

"Sulla dilatazione del fosforo: di G. Pisoli E. C. de Franchis." Pamphlet, 8vo. 46 pp. with plate.

This paper is a reprint of one published in *Gazetta Chemica Italiana*, vol. iv. 1874, on the expansion of phosphorus both solid and liquid. Some observers have declared that the specific gravity of liquid phosphorus was higher than that of the solid, but the authors of this paper, in accordance with other observers, have determined that the reverse is the case. The paper is a record of a number of careful experiments made with solid phosphorus between 0° and 45°, and with liquid, between 20° and 280°. Pure commercial phosphorus and phosphorus which had been distilled both once and twice in a current of hydrogen, was examined. Naturally some difficulty was experienced at the higher temperatures from the formation of red phosphorus, though this difficulty was avoided as far as possible. The results for the three different qualities of phosphorus experimented upon were quite concordant, and show that both for solid and liquid phosphorus the expansion is quite regular, a curve drawn in the plate accompanying the paper presents this fact in a more striking manner. E. W.

"The Trap Rocks of the Connecticut Valley." By George W. Hawes. Pamphlet, 8vo. 8 pp. 1875.

"The Mineral Resources and Manufacturing Facilities of the City of Cumberland, Md." With map and tables showing connections by rail and water with all the important centres of trade. By C. J. Orrick, with an article on Iron by A. F. Wendt, E.M. Pamphlet, 8vo. 31 pp. 1875.

"Second Annual Report of the New Jersey State Board of Agriculture, for the Year ending, 1874." Pamphlet, 8vo. 85 pp. Trenton, 1875.

Report of the Board of Administrators of the Charity Hospital to the General Assembly of Louisiana—Session of 1875. Pamphlet, 8vo. 113 pp. New Orleans, 1875.

Ueber Untersuchung des Bieres auf fremde Zusätze. Von G. C. Wittstein, a. d. Arch. d. Pharm. Pamphlet, 8vo. 8 pp.

The Coal Measures of Beccaria, Clearfield County, Pa. By J. P. Kimball, Ph.D. Pamphlet, 8vo. 21 pp.

Proceedings of the American Academy.—VI On the wide Diffusion of Vanadium and its Association with Phosphorus in many Rocks. By A. A. Hayes, M D. Pamphlet, 8vo. 6 pp.

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Carte Agricole de la France. Extrait du Bulletin de la Société de Géographie. Par M. Lelesse. Pamphlet, 8vo. 24 pp. Paris, France, 1874.

Clinical Lectures on Diseases of the Nervous System. By Wm. A. Hammond, M.D. 8vo. 287 pp. New York, 1874.

Histology and Histochemistry of Man. By Heinrich Frey, 8vo. 683 pp. New York, 1875.

Report upon the Sanitary Chemistry of Water. By C. F. Chandler, Ph.D., M.D., LL.D., Pamphlet, 8vo. 31 pp. Cambridge, Mass., 1875.

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Ueber die Quantitative Bestimmung des Arsens, respective der Arsensäure. Von G. C. Wittstein, 2 pp.

Proceedings of the American Pharmaceutical Association, 1874, Vol. XXII. 8vo. 656 pp. Philadelphia, Pa., 1875.

Observations on the Phenomena of Plant Life. By Prest. W. S. Clark, State Agricultural College, Amherst, Mass. Pamphlet 8vo. 111 pp. Boston, Mass., 1875.

The Coal Trade. By Frederick E. Saward. Pamphlet, 8vo. 104 pp. New York, 1875.

On the Composition of the Ground-Atmosphere, together with some Examination of the Air in Smoking Cars. By Prof. Wm. Ripley Nichols. Pamphlet, 8vo. 27 pp. Boston, Mass., 1875.

Eine bis jetzt vernachlässigte Jodquelle. Jod und Brom in den Süsswasserpflanzen. Von H. Zenger. Pamphlet, 8vo. 14 pp. Munich, Bavaria.

Geological Survey of Alabama. Report of Progress for 1874. By Eugene A. Smith, Ph.D. Pamphlet, 8vo. 139 pp. Montgomery, Ala., 1875.

Ueber die Prüfung des Kaffees. Von Prof. G. C. Wittstein. Pamphlet, 8vo. 5 pp.

Geological Survey of New Jersey. Annual Report of the State Geologist for the Year 1874. By George. H. Cook. Pamphlet, 8vo. 115 pp. Trenton, N. J., 1874.

Report of Sewerage in the City of Providence. Pamphlet, 8vo. 84 pp. Providence, R. I., 1874.

The Addresses delivered at the Twenty-sixth Annual Commencement of the Medical Department of the Georgetown University. By Benj. S. Hedrick, M.A., Ph.D.; J. M. Green, M.D.; and Joseph Taber Johnson, A.M., M.D. Pamphlet, 8vo. 39 pp. Washington, D. C. 1875.

Results of Examinations of Water from the River Schuylkill. By Charles M. Cresson, M.D. Pamphlet, 8vo. 16 pp. Philadelphia, Pa., 1875.

Sixth Annual Report of the State Board of Health of Massachusetts. January, 1875. Pamphlet, 8vo. 379 pp. Boston, Mass., 1875.

BREVITIES.

A New Photographic Light.—An artificial light, new in its proposed application, which, it is probable, may be found useful for photographic purposes, was exhibited at the meeting of the Photographic Society on Tuesday evening last. Mr. Spiller's object had been to devise a light as rich in actinic rays as possible, involving less trouble, cost, and risk than attended the various artificial lights which had hitherto been proposed and applied to photography. The electric light and the oxyhydrogen are cumbrous and costly; incandescent magnesium is costly, and the dense fumes emitted are inconvenient; the recently proposed lamp to be supplied with nitric oxide and bisulphide of carbon is attended with risk; and some others have each specific inconveniences The light proposed by Mr. Spiller is derived from nitrate of potash and sulphur. When nitrate of potash is submitted in a capsule or flask to the heat of a spirit flame somewhat beyond the point of fusion, and a succession of small pieces of sulphur introduced into the fused nitre, it bursts into a brilliant white flame of dazzling intensity, resembling or exceeding that of phosphorus in oxygen. One part of sulphur to three, or a little more, of dry saltpetre is consumed in the process. Only half the normal amount of sulphurous acid evolved in the combustion is given off in fumes, the remainder being held in the residue, and there are no solid particles given off in the fumes. The mere cost of the material is comparatively small, that of the sulphur and nitrate of potash necessary for maintaining a very intense light for ten minutes being about one halfpenny; but the wear and tear of apparatus in producing a flame of intense heat remain to be estimated. The mode of maintaining a constant light, and the best means of making it practically available in photography, must also remain matter for further experiment.—*Photographic News.*

Dr. J. Emerson Reynolds has been appointed to the University Professorship of Chemistry in Trinity College, Dublin.

Lecture Experiment.—The common lecture experiment of igniting a mixture of potassic chlorate and sugar by means of concentrated sulphuric acid may be somewhat improved if the dish holding the mixture to be burned be previously moistened with the acid, instead of dropping the acid into the mixture. This prevents scattering of the materials. So says, at least, Mr. Gawaloski.

Prof. John Phillips.—A cable dispatch from London announces the death of John Phillips, M A, LL.D, D.C.L., F.R.S., F.G.S., the eminent English geologist. Prof. Phillips, who was the nephew of the celebrated William Smith, "the father of British geology," was born on Christmas Day in the year 1800, and was consequently in his seventy-fourth year. He was the author of several standard works on geology, and since the year 1826, when his first book was published, had contributed sixty books and papers to geological literature, the majority of them being the records of original researches Among the latest of his writings are a work on the geology of the valley of the Thames, and a history of Vesuvius. While acting as Secretary to the British Association, deceased compiled and edited twenty-seven volumes of the records of that learned body. In 1858 and 1859 Prof Phillips was elected to the Presidency of the British Geological Society, and in 1864 filled the same office in the British Association. He filled the chair of Professor of Geology in King's College, London; Trinity College, Dublin; and Oxford University, and received the doctorate from the Universities of Dublin, Cambridge, and Oxford. Prof. Phillips contributed to meteorology his work entitled *Three Years' Observations on Rain at Different Heights from the Ground*, and several valuable inventions, which have been generally adopted. He made several researches on the physical aspect of the sun, moon, and Mars, and participated with Gen Sabine in a magnetic survey of the British Islands.—*N. Y. Times*, April 25, 1874.

Lyceum of Natural History in the City of New York.—Chemical Section. Monday, April 12, 1875, the following papers were read: Prof. William Falke, on Hydrogenium; Mr. W. P. Jenney, on the Production of Solid Hydrocarbons by the Action of Air on Refined Petroleum.

CORRECTION.

Editors of the American Chemist,

Dear Sirs: On page 314 of the February number of the American Chemist, under the head of *Brevities*, you notice some remarks made by me on certain points in theoretical organic chemistry at a recent meeting of the Lyceum of Natural History in the city of New York, in which notice two unfortunate typographical errors occur, one of which is twice repeated.

In line 9 "CHOH," should be CH_2OH, and in lines 9 and 12 for "carbhydral" read *carbhydryl*.

The first mentioned error will suggest itself to every reader, but the second is not patent.

The term *carbhydryl* is uniform in construction with *carboxyl*, and may with propriety be applied to the group CH_2OH existing in all true alcohols.

H. Carrington Bolton.

THE AMERICAN CHEMIST.

Vol. V. No. 12.

ANALYSIS OF ROCKS.

BY T. EGLESTON.

Paper read before the St. Louis Meeting of the American Institute of Mining Engineers.

How to interpret the composition of rocks has been a question which has caused a great deal of discussion and investigation among geologists and chemists. It is evident that that analysis will give the clearest results which will give both the composition and the proportion of the different minerals constituting the rocks. This, however, is a very difficult matter, and, in those rocks which seem to the naked eye entirely compact, like obsidian and other rocks of that class, appears to be impossible. Cordier, in the early part of the century, invented a process which is known as the mechanical analysis of rocks, which is really a method of mechanical preparation, and consists in crushing the rock to a certain fineness and then by virtue of their density washing out the different minerals so as to make a mineralogical analysis, separating completely the different constituents of the rocks. In the hands of so skilful a man this was a comparatively easy matter, and Cordier found no difficulty in ascertaining the mineralogical composition of a rock. The chemical composition of the different minerals was then easily determined.

In the light of to-day it is very easy to see that the complete chemical analysis of the rock does not necessarily lead to the explanation of its character. It has been so difficult, however, to have any other kind of analysis made that most chemical examinations have been made as ultimate and not as mineralogical analyses. The panning out of the different minerals composing the rock, which are often very nearly of the same specific gravity, is so difficult that a person of ordinary mechanical skill is scarcely able to do it; consequently the mechanical analysis which Cordier proposed and was able himself so skilfully to effect has never been practised to any extent. A school was formed in France consisting of a very small number of Cordier's followers, which, in face of the difficulty of acquiring the method, very soon died out as a school, though some of his most skilful followers are still living. The next important step in ascertaining their composition was to cut the rock into transparent sections and examine the mineral with the microscope, which gave results more or less certain.* The adaptation of polarized light to the study of these thin sections was almost of necessity the next step in order, and was for a very long time supposed to be almost the *ultima thule* of lithological investigation. Notwithstanding, however, the great hopes which were entertained and the thousands of sections which have been cut and investigated, less has been derived from these investigations than was at first hoped. The machinery which is required for cutting and grinding the surfaces necessary for examination for micro-analysis by polarized light is expensive, and the skill required, and time necessarily consumed, are such that few feel warranted in undertaking the method, though the difficulty is more in imagination than reality. The lithologists are still looking for some method of investigation which shall be as certain and less difficult of accomplishment.

In 1873, while studying micro-lithology, I had the good fortune to make the acquaintance of M. Fouqué, of the College of France, who had been studying for some years the volcanic rocks of Santorin, and who, finding all the known methods for examining these rocks unsatisfactory, has invented one of his own, which is within the reach of every chemist or lithologist, and with a few additions taken from other methods is of general application. After making a careful microscopic analysis of the rocks of that country, and ascertaining that although nearly compact they were composed of a large number of minerals,* and that these microscopic minerals, like most of those which are larger, are rarely ever pure, but are filled with inclusions both solid, liquid, and gaseous, M. Fouqué invented a process which is partly mechanical and partly chemical. It consists: 1. In reducing the rock to powder and separating by means of graduated sieves the coarse parts from the fine powder. 2. In order then to separate those parts which contain iron from those which do not, the powder is submitted to the action of an electro-magnet worked by eight or nine ordinary Bunsen cells. The mineralogical elements of the rock are thus divided into two parts, those which contain iron, even in very small proportions, whether combined with silica or not, and those which contain no iron. The white powder in ordinary cases is composed almost entirely of feldspathic minerals, which when there are several varieties may be separated either by differences in their size (for they are rarely ever crystallized in the same way), or by the fact of their being unequally acted upon by acids. In order to ascertain the composition of the other parts of the rock, M. Fouqué uses concentrated fluo-hydric acid, which, when the temperature is not raised, and the action not too prolonged, attacks the feldspars only, and leaves behind such minerals as magnetite, pyroxene, and chrysolite.

Magnetic iron is easily removed by the magnet, and pyroxene and chrysolite may be separated by their color with a magnifying glass, or attacked by a weak solution of sulphuric acid, which acts upon the chrysolite and does not attack the pyroxene. By the ap-

* Some observer has proposed to make a drawing of the enlarged section on a thin sheet of paper, and then to cut the outlines of the different minerals apart and weigh them, and thus ascertain the relative proportion of the different minerals. It is said that quite accurate results are obtained in this way.

* The rock resembles obsidian with small whitish crystals scattered through it.

plication of this exceedingly simple method, M. Fouqué was able not only to determine but to separate and analyze three varieties of feldspar, albite, labradorite, and anorthite, and at least two varieties of pyroxene and chrysolite, besides magnetic iron, and to separate them so that it was possible to make a complete analysis of each of them. The use of a low power microscope is indispensable in these operations, both to see that the crystals with small inclusions have been removed, and also to watch the effect of the different acids.

The first operation consists in reducing to powder two or more kilogrammes of the rock and sifting them so that all the grains shall be of a uniform size and about a quarter of a millimetre in diameter. This powder is divided into two parts, which are to be treated differently. The first of these is submitted to the electro-magnet, which for convenience is suspended by a wire to within three or four centimetres of a table. The material to be acted upon is placed upon a sheet of paper which is raised in the two hands and moved close under the magnet. One of the ends of the wire is so arranged as to fit the clamp screw without the necessity of being clamped. After the paper has been moved several times underneath the magnet, it is withdrawn from it and placed to one side of the table. Another paper is now brought under the magnet, and the wire which is not clamped removed. All the material containing iron, of whatever form it may be, that has been attached to the magnet, falls to the paper. The wire is then replaced, and this process is repeated a number of times until the microscope shows that all the powder that remains on the first paper is free from any coloring matter and entirely white. This operation requires a great deal of patience and care, because there are in different feldspars very small inclusions, which are not easily taken up, but which must be removed. All the material containing any considerable percentage of iron, whether a silicate or not, is removed in the two or three first passes, and then it requires a careful observation with the glass, to ascertain, after fifteen or twenty passes have been made, whether there is anything which should still be eliminated from the mass. It required thirty to forty passes under the magnet to remove all the material containing iron from a somewhat decomposed basalt rock of New Hampshire.

The white residue which is left is composed almost entirely of feldspar, and generally the grains of each species will be of different sizes and often will be either crystals or crystalline in form. On submitting these feldspathic grains to the action of moderately strong muriatic acid, they are either attacked or not attacked. Those which are not attacked will be orthoclase, albite, and labradorite, and those which are will generally be anorthite.

The second part of the powder is acted upon by fluohydric acid, which, when its action is not too long, nor the temperature too high, dissolves at once the feldspars and amorphous matter of the rock, and leaves behind a crystalline residue composed of such minerals as pyroxene, chrysolite, and magnetite. The magnet takes out the magnetite, and the chrysolite and pyroxene may be separated with a glass by their difference in color or by their different solubility in acids. In this way sufficient material was collected to make analyses of all the different minerals of a rock, apparently compact; namely, two kinds of pyroxene and chrysolite, magnetite, albite, anorthite, and labradorite. M. F. communicated his results to the Academy of Sciences in May and June, 1873.

To complete this work the rock was cut into sections and photographed, and for this particular work M. Fouqué had become so skilful, that he was able in the photograph to point out each variety of the different minerals and to control his determination by the analysis that had been previously made. He found in his observations that all the different feldspars in the rocks in Santorin were in crystals of different dimensions, and that they could be easily recognized by their structure alone after studying the rock.

On examining these slides made from the rocks by polarized light by the methods proposed by Tschermak, Rosenbusch, and others, the crystals were determined in the rock. After working for some time upon the rocks of New Hampshire, and using them both as sections and with the method of M. Fouqué, it occurred to me that it was not always necessary to cut sections, but that a simple examination of the powder before passing under the magnet would be quite sufficient. I found it quite difficult to prepare these slides, but finally adopted the plan of using a few drops of a very thin solution of Canada balsam in chloroform placed upon a microscope cover-glass, upon which a sufficient quantity of powder was afterwards placed. With a glass magnifying five or six diameters, it was easy with a needle point to separate all the different grains, and then by evaporation to have them all kept in their place by the small quantity of Canada balsam. This cover-glass was afterwards turned down upon a drop of Canada balsam, and in this way I succeeded in mounting a large number of slides which answered all the purposes of sections.

M. Fouqué's method must be considered as an important step in the progress of lithology. One of its greatest advantages is, that it furnishes for analysis very small crystals which are always purer than large, and are much less likely to contain inclusions. It is besides a method which any person possessed with a moderate amount of patience can readily learn, and with a few variations is applicable to all varieties of crystalline rocks.

School of Mines, Columbia College, N. Y.,
May 25, 1875.

ESTIMATION OF ANTIMONY.

BY E. H. BARTLEY,

Instructor of Chemistry in the Cornell University.

It is well known that the separation and estimation of antimony present some difficulties, which, with students, are not easily surmountable.

In the usual gravimetric processes for the estimation of antimony, the precipitated sulphide, together with some free sulphur, is either dried at 100° C. and weighed, and then the antimony is estimated in a portion of this residue, or, as Thorpe has recommended, this residue is washed from the paper and oxidized with fuming nitric acid directly, without previous drying at 100°, and the antimony is weighed in both cases as Sb_2O_4.

The oxidation of sulphur, as above, is quite difficult to complete, unless the acid is very strong; and, even then, it requires considerable care and patience. To avoid this difficulty, as well as the uncertainty always attending the use of a tared filter, I have made use of bromine and ordinary nitric acid to effect the oxidation of the sulphur and sulphide of antimony.

The oxidation by this means is rendered quite easy and complete; for the dry mixture of sulphur and sulphide easily dissolves to a red liquid in bromine, which is decomposed by ordinary strong nitric acid, giving rise to hydrobromic acid, sulphuric acid, nitrous fumes, and antimonic acid.

The oxidation of the sulphides of arsenic may be effected very easily in the same way. The use of bromine alone or with hydrochloric acid is recommended by Waage,* in Fresenius's *Zeitschrift* for 1871, p. 206, and combined with nitric acid it seems to be applicable in nearly every case where fuming acid is usually used.

In the application of the above to the analysis of type-metal, I proceed as follows:—

The finely divided alloy is treated in a beaker with nitric acid until completely decomposed. The excess of nitric acid is neutralized with ammonic hydrate, yellow ammonic sulphide is added in considerable excess, and the mixture is digested until the antimony is in solution.

It is now filtered; the residue is washed, dried, ignited, and weighed as sulphide, or sulphate, with the usual precautions.

The ammonic sulphide solution of the antimony is acidified with hydrochloric acid, and digested with frequent stirring until the sulphydric acid is expelled, and the supernatant liquid is clear. Filter, wash until the washings give no reaction for hydrochloric acid, and dry. The dry precipitate is detached as completely as possible from the filter into a beaker; the filter is returned to the funnel, perforated, and washed with bromine, taking care to wet every portion of the paper, and allow the bromine to run into the beaker. Cover the funnel with a watch glass, and allow to remain a few minutes, and then wash the paper once or twice with water, allowing the washings to run into the beaker. This is usually sufficient to remove the precipitate; but to guard against loss I remove the paper to an evaporator, and digest with some water until the color is entirely washed from it, when it is removed, washed out, and these washings evaporated to small bulk, transferred to a capacious weighed porcelain crucible, evaporated to complete dryness with excess of nitric acid, and fused with a crystal of ammonic nitrate to insure the destruction of organic matter.

The contents of the beaker are warmed gently with some nitric acid, which must be free from chlorine, until the precipitated antimonic acid is of a pure white color.

The decomposition usually takes place quite violently, and the beaker should be kept carefully covered with a convex glass.

If sulphur should separate after the first treatment, bromine may be added a second time. The contents of the beaker are finally transferred to the crucible and evaporated to dryness, ignited, and weighed as Sb_2O_4. The final evaporation may be considerably hastened without danger of spurting, by heating the crucible entirely by radiation from above; but, of course, the crucible must be protected from reducing gases.

This process takes less time, and gives results more satisfactory, in the hands of my students, than the above mentioned processes. I append some figures which may serve to show the degree of accuracy attainable by this method. Numbers 1 and 2 were from the same specimen of stereotype metal; while number 3 was a separate specimen.

	Lead.	Antimony.	Total.
No. 1	78·05	21·90	99·95
" 2	77·98	22·11	100·09
" 3	77·29	22·69	99·98

This process has been in use in this laboratory this term with satisfactory results, and I think will prove a valuable improvement in the methods of estimation of antimony.

Cornell University, Ithaca, N. Y.,
May, 1875.

* This Journal, vol. ii., Oct. 1871, p. 131.

DETERMINATION OF TOTAL CARBON IN CAST IRON.

BY C. ALVARGONZALEZ.

To determine the total carbon the cast iron is attacked by a salt of copper, the sulphate being generally preferred. The result of the reaction is that the iron is dissolved, leaving a residue consisting of metallic copper, carbon, and some silica. A certain portion of the carbon is left in the residue as hydrocarbons. Upon washing it with benzol I have obtained a substance strongly resembling coal tar.

The course generally adopted has been to oxidize the residue and to estimate the carbon as carbonic acid. Although in theory this is correct, the results obtained in practice are far from being satisfactory, unless the process be carried out by a person of unusual skill and experience. The apparatus is necessarily complicated, troublesome to put together, and yields very unsatisfactory results with many operators.

These considerations have induced me to try to estimate the total carbon by loss. Although Fresenius* says that methods founded on determination by loss are

* See English Translation, 1v. Edition of Bullock and Vacher, London, 1865, p. 658.

not reliable because the carbon precipitated with the metallic copper is not all in the state of pure carbon, the results that have been obtained, not only by myself, but by several fellow students, prove the accuracy of the method.

The method that has been adopted is very simple and expeditious. It is as follows: Ten grammes borings of cast iron are treated with a solution of neutral sulphate of copper (formed with forty-one grammes of sulphate dissolved in the necessary amount of water) until the reaction ceases.

The result of the reaction is a mixture of metallic copper, graphite, hydrocarbons, and a certain portion of silica. From this mixture the copper must be separated. Instead of using for this purpose chloride of copper and hydrochloric acid, as recommended by Eggerz, I use dilute nitric acid, which attacks the copper in a much shorter time. Although this course has met with disapproval on account of the liability of nitric acid to oxidize the carbon, the results obtained show that sufficiently diluted nitric acid has no action on it.

After the copper has been dissolved, dilute the solution, and collect the precipitate on a filter; wash it thoroughly and dry, when it will become detached from the filter, and it may be placed in a platinum crucible.

As it is necessary that the precipitate be detached as thoroughly as possible from the filter, I have adopted for this analysis the filter of Mr. Rother,* which has no folds, and in which the precipitate is spread on a smaller surface than on other conical filters. The precipitate may be separated from the filter with a feather, the quantity of carbon left on the paper being inappreciable. The filter is not used after the carbon has been removed from it, and may be thrown away. After the precipitate has been thoroughly dried at 100° C. and weighed, the carbon is burned over a Bunsen burner, and estimated by loss.

The following results have been obtained:—

Analyses by F. A. Cairns. By the CO_2 method.	Analyses by the students. By loss.
4·10 per cent.	4·28 per cent.
4·01 "	3·99 "
3·80 "	3·79 "
4·10 "	4·16 "
3·80 "	3·75 "
3·80 "	3·68 "

Some of the results obtained are slightly higher than those given by the estimation by direct weight. This may be due to estimating as carbon the impurities which accompany it. The slight difference between the results obtained by these two methods is probably owing to the circumstance that the principal impurity accompanying carbon is hydrogen, whose equivalent is very low.

Laboratory of the School of Mines,
Columbia College, N. Y., May, 1875.

* Described by Mr. Proctor, Chem. News, Jan. 30, 1874, p. 57.

IMPLEMENTS FOR FILTRATION.

BY P. CASAMAJOR.

I.—*Filter Pump.*

In American Chemist for April, 1874, I gave a description of a *new apparatus which may be used as filter pump or laboratory bellows.* Since sending this communication, I have used this apparatus almost constantly as filter pump, but having very seldom to use it as bellows, I have disconnected the two portions and tacked the part which forms a filter pump to the wall over a sink into which the water runs after leaving the aspirator. The portion used as bellows is, as explained in the article mentioned, a bottle closed by a cork having two holes, one to admit the aspirator and the other a tube for carrying off the air. There is at the lower part a nozzle for getting rid of the water after the bubbles of air have been separated from it. As now modified, the cork which closes the mouth of the bottle bears two tubes, one reaching to the bottom and the other starting from the top of the bottle. This latter tube carries off the air, while the other, when the apparatus is in use, must be connected with the tube which carries away from the aspirator the water charged with bubbles of air. Beyond this brief mention, we do not propose in this article to call attention any further to this blowing apparatus, as it has no relation to the subject of filtration.

The filter pump itself is very easily put up by using elements which are at hand in every laboratory, which circumstance induces me to call attention to it again, particularly as it has been much improved, and the results now accomplished are much superior to those previously announced. To give an account of the changes adopted, I propose to give a brief description of this aspirator, and afterwards to call attention to the points that are of most importance if advantageous results are to be obtained.

The aspirator, as now used, is represented in Fig. 1, in which *A* is a tube which conveys water from the hydrant or from an upper reservoir. The extremity of this tube, through which the water escapes, has a contracted outlet, which gives increased velocity to the water as it enters the tube *b*, which forms the lower part of the vacuum chamber *B*. To the tube *b* is attached a rubber tube *C*, which is curved at *D* into a loose knot. The lower portion of *C* hangs over a sink into which the water is discharged after leaving the apparatus. Through the cork, which carries the tube *A*, passes also the vacuum tube *E*, which establishes a communication between the vacuum chamber *B* and the bottom of a funnel or a bell glass.

The first point of importance to be attended to, if we wish to obtain good results, relates to the shape of the lower extremity of tube *A* and to the size of the opening for the egress of the water. The best results have been obtained by making the lower end of *A* somewhat truncated (see Fig. 2) and making the hole in it not more than one-sixteenth of an inch in diameter.

Fig. 1.

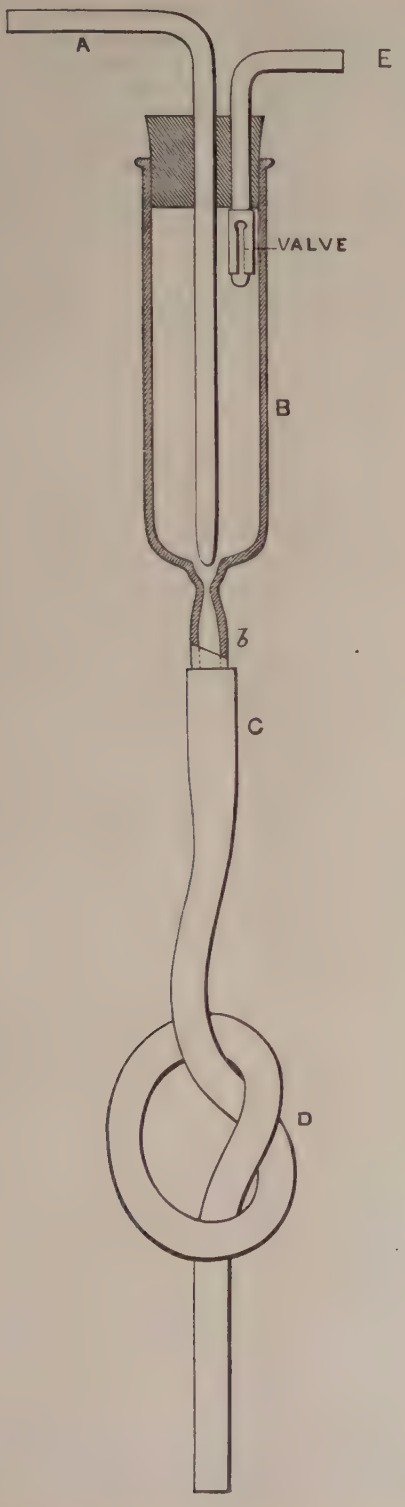
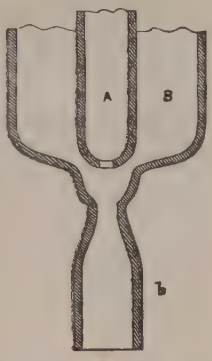


Fig. 2.



The tube should be elongated by heating over a flame until the interior diameter is reduced to about one-eighth of an inch. A cut with a file will sever the tube, after which the portion which is to form the extremity of *A* has to be heated again until the glass is softened, when, by pressing the end of the tube against any hard surface, it will become blunted and the hole will become contracted. The object of flattening the end of tube *A* is to cause the water to come out of the opening somewhat obliquely, which makes a better vacuum than when the water escapes from an elongated cone. The opening for the escape of the water is reduced to allow the pump to work with a smaller supply.

The tube *b*, which forms the lower portion of the vacuum chamber *B*, should be drawn to a diameter of about one-eighth of an inch at the narrowest part, which ought to be immediately below the lower end of tube *A*, as shown in Fig. 2.

To the lower portion of tube *b* is attached a piece of rubber tubing loosely knotted, of which we have already spoken. The knot formed by this tube acts as a trap, which remains full of water while the aspirator works and prevents the introduction of air from below to satisfy the vacuum in vessel B.* This object I sought to accomplish formerly by dipping entirely in water the end of the tube carrying the water away from *b*; but this course is objectionable, for, whenever the pressure in the tube *A* diminishes, and the impact of the water on the tube *b* is not sufficient to maintain the vacuum in the chamber *B*, the water from below rushes up into the vacuum chamber, and when the tube which is a prolongation of *b* dips into a large body of water, the vacuum chamber itself and every vessel communicating with it is in danger of being flooded. The advantage of using the trap formed by recurving the tube *C* is, that the quantity of water held in the recurved portion is only sufficient to fill a portion of the vacuum chamber whenever the water rushes up into it.

I have said that this aspirator may be constructed by using elements which may be found in any chemical

* This trap is useless if the aspirator is well constructed; otherwise it increases the vacuum, but in no case is it hurtful.

laboratory. The only apparent exception to this is the vacuum chamber *B*, with its appendage, the tube *b*, but the difficulty of obtaining this piece is easily overcome by making the tube *b* of an independent piece of tubing, and connecting it to a vacuum chamber by passing it through a cork. The vacuum chamber may then be made of a glass tube having a diameter of one inch or one and a quarter inch and closed by corks at both ends, the upper corks carrying the tubes *A* and *E*, while the lower cork will bear the tube *b*.

Many vessels may be utilized for making up the vacuum chamber *B* and its annexed tube *b*; I may cite as an instance a filter pump I have in use, in which the vacuum chamber is a cylindrical bottle having a diameter of one and a quarter inches, and a length of five inches, such a bottle as is used for exhibiting samples of refined petroleum. The bottom was knocked out by dropping an iron rod into the bottle, which operation left an opening which is now closed by a rubber stopper bearing the tubes *A* and *E*, while through the exmouth of the bottle passes the tube *b*. As the difference between the interior diameter of the opening and the exterior diameter of the tube *b* is only one-eighth of an inch, the space has been filled by passing the tube *b* through a piece of rubber tubing before inserting it in the vacuum chamber.

The vacuum chamber *B* may be of smaller dimension than the one I have just cited. It is necessary, however, that its diameter should be sufficient to admit of its being closed by a cork capable of carrying both the tubes *A* and *E*. The capacity of the vacuum chamber should be such that the water in the recurved rubber tube may find room in it whenever the flow in the tube *A* is suddenly checked.

To maintain the vacuum beyond the vacuum chamber, when the flow of water is checked or diminished, it is necessary to place a valve on the tube *E*. The valve adopted (see Fig. 1) is of the simplest description and requires only a few minutes to construct it. It is made by closing the end of a glass tube by melting over a lamp, and, on the side of the tube, about an inch from the end, making a hole with a file previously dipped in petroleum to prevent it from cracking the tube. Over this glass tube we then slip a rubber tube about an inch long and having a longitudinal slit about three-quarters of an inch long. About one-quarter of the length of the rubber tube is left entire, which forms a ring to retain the rubber on the glass tube. The slit should be placed diametrically opposite the hole made on the side of the glass tube. When placed in this manner the rubber tube may be considered as a loose flap placed over the hole; it opens out when air is blown into the tube and closes when the air is sucked out. To ascertain the best place in which to place the rubber tube over the opening, a few trials are necessary by blowing and aspirating at the open end of the glass tube. If the hole in the glass tube is too near the ring or entire part of the rubber tube, the valve will not open when the air is blown in, while, on the other hand, if the side hole is too far from the ring, the valve will not close when air is aspirated from the tube. To prevent the slit from extending in time the whole length of the rubber tube, it should terminate at the end near the ring, in a round hole or a transversal slit.

In the description of this aspirator previously given (American Chemist for April, 1874), I said that it could only be used when the pressure in the hydrant was very high. I have, however, obtained very good results with moderate pressures since the improvements which have been described in this article were adopted.

The following table shows the results for different pressures:—

Pressure in the hydrant in lbs.	Vacuum in inches of mercury.	Water spent per minute in litres.
2	2¼	0·50
4	3¼	0·75
8	5	1·
16	10½	1·33
20	16½	1·45

I use habitually a pressure of 8 lbs., which produces all the necessary effects without straining the rubber pipes which connect the hydrant faucet to the tube *A*.

In calling attention to this simple and effective apparatus for the second time, I wish to have it well understood that I do not claim to have discovered any new principle or any application of a principle. My object has merely been to afford directions to enable any chemist, who desires to have a filter-pump, to make one for himself in a short time and at a small expense.

II.—*New Funnels for Filtering under Pressure.*

Although the advantages resulting from the use of filter-pumps are obvious, these useful implements are comparatively little used. This circumstance cannot be attributed wholly to the difficulty or expense attending their construction, for many laboratories are provided with them in which they remain idle because operators prefer to work without them. The chief objection to their use is that, if any portion of a paper filter is not properly supported, it will be inevitably torn as soon as a vacuum is formed under it. This accident happens so often that most chemists are unwilling to risk the loss of an analysis for the sake of saving time in filtering.

The plan generally adopted for preventing the tearing of filters is to use a perforated cone made of platinum foil, which is placed so as to support the apex of the paper filter. For the sake of greater safety, instead of a single filter, two are used, one lying within the other. The portion of the filters above the platinum cone is pressed tightly against the sides of the funnel. This is the plan of Professor Bunsen. It generally gives satisfactory results when great care is taken; but sometimes, even after giving the greatest attention to the security of the paper filter, it becomes torn and the precipitate goes through. Often, when the liquid has passed through clear, have I found part of the precipitate between the inner and outer filter.

After trying many ways of overcoming this difficulty, I was fortunate enough to find a plan which answers so perfectly that I am able to say that torn filters and lost precipitates are things that trouble me no more. It is my purpose to describe this plan here, and, as it was suggested to me by a process of filtration published by Dr. H. Carmichael,* I propose to give a brief account of Dr. Carmichael's process and afterwards to give a description of my plan.

In the process proposed by Dr. Carmichael, which may be designated *upward filtration*, a liquid holding a precipitate in suspension instead of being filtered by placing it in a paper cone held in a conical glass funnel, is poured into a platinum dish and the liquid is separated from the precipitate by the agency of a small paper disk held against a perforated surface belonging to a vessel, the interior of which communicates with an aspirator. While one side of the paper disk adheres to the perforated surface, the other side is in contact with the contents of the platinum dish, so that when the pressure is reduced in the vessel the liquid passes through the paper leaving the precipitate in the dish.

In Dr. Carmichael's arrangement the vessel is a bulb blown at the end of a glass tube, and the surface against which the paper adheres is a part of the bulb which has been flattened and riddled with holes.

This arrangement solves completely the problem of supporting the whole surface of the paper filter, as this is a flat disk resting on a flat perforated surface. There is, however, a serious drawback to using this arrangement, which is that the construction of its most important element is, to say the least, a very difficult matter. To obtain the perforated surface the following directions are given in Crookes's *Select Methods of Chemical Analysis*, p. 431: "Take a glass tube having an inner bore of 2 mm.; blow at one end a thick bulb; flatten the bulb at the bottom; keep this bulb so hot that the glass is only slightly softened, and, while in this condition, make holes in it by means of a white-hot steel wire."

After trying several plans to accomplish the same result in a more satisfactory manner, I had the good fortune to find the following solution. It consists in the simple expedient of supporting the circular paper filter by a thin perforated metallic disk, applied to the inside of the funnel. The filter is to be made somewhat larger than the metallic disk, so that its edges may rest on the funnel; and the funnel itself must have such a shape that the angle between the metallic plate and the funnel be very obtuse (about 165°). The deformation of the paper filter in that case is not perceptible; but if the angle should be too small, the edges of the paper filter will not lie flat on the funnel, and it will not be possible to have a tight joint.

In Fig. 3 and Fig. 4 are represented the funnels I have adopted; in Fig. 3 is represented the funnel for filtering in the manner recommended by Dr. Carmichael; and in Fig. 4 the one for ordinary downward filtration, which form I use most frequently. With this funnel satisfactory results may be obtained even without a filter-pump, as will be presently shown.

Fig. 3.

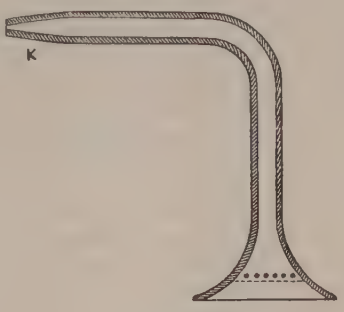
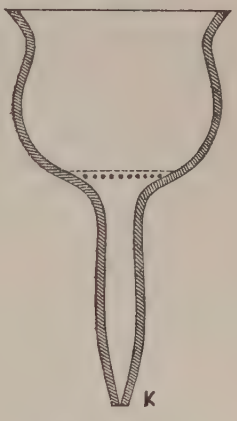


Fig. 4.



The funnel represented in Fig. 3 resembles somewhat a Plattner blowpipe mouth-piece. To make use of it, we lay one or two circular paper filters on a perforated metallic disk, having a somewhat smaller diameter. If now the funnel is placed in communication with the vacuum formed by a filter-pump, and the paper filter is moistened, it will adhere to the funnel when applied against its interior surface. In applying the filter and metallic disk care should be taken that the disk be placed inside and the filter outward. I have sought to indicate the metallic disk by a line of coarse dots, while the paper filter is represented by a fine dotted line. Platinum is the best material for making the perforated disks, which may be easily riddled with holes with a coarse needle. For many purposes perforated tin plate and brass answer very well. As to their sizes, I may say that those I use have diameters of 1 inch to 1¼. The paper filters are ¼ inch larger. With these small surfaces the results obtained are much superior to those given by conical filters made from disks of six inches diameter.

* See Select Methods of Chemical Analysis, by William Crookes, F.R.S., p. 429.

After a precipitate has been thoroughly drained and washed, it may be allowed to dry by continuing the action of the filter-pump for some time. After stopping the action of the filter-pump, if the funnel be slightly shaken, the paped filter and perforated metal plate will remain in the platinum-dish, while a small portion of the precipitate will still adhere to the funnel. The metallic disk, lying on top of the precipitate in the dish, is very easily removed by forceps. To remove the small portion of precipitate adhering to the funnel, it should be dried by placing the funnel in a porcelain dish and heating slightly. When dry it may be entirely removed from the funnel with a feather and added to the contents of the platinum dish.

With some precipitates there exists a remarkable peculiarity, to which it is not useless to call attention to show how the trouble caused by it may be avoided. An instance of a substance, showing the peculiarity in question, is the fine powder obtained when bone-black has been treated with hydrochloric acid so as to dissolve the calcic salts. If this fine carbon and the liquid accompanying it are thrown in the platinum dish, the liquid will be taken up by the aspirator as long as enough water remains with the finely divided carbon. When most of the water has been separated the carbon becomes quite firm and adheres like a cement to the filter, so that no amount of suction can free the tube *h* from the water it holds. The tube may be drained, however, by inserting a very fine needle under the paper disk after the precipitate has become quite firm; this opens a small air-passage, and the liquid in the tube is immediately aspirated.

Funnel for Filtering Downwards.—This funnel is represented in Fig. 4. The metallic disk is represented by a line of coarse dots, while the paper filter is shown by a fine dotted line. The shape of the funnel, in the portion near the filter, is the only essential part. The general form of it has been adopted for the greater convenience of the glass-blower. The end *k* is made tapering so as to connect and disconnect with the aspirator by insertion in a rubber tube. The filtering disk is placed in this funnel as in the one represented in Fig. 3. If two superposed filters are used instead of a single thickness, the filtration will be quite as rapid while the safety will be greater. Before pouring the liquid in the funnel it is always advisable for greater safety to press down the margin of the filter, so as to insure the closing up of any minute opening left by a fold in the paper. This recommendation applies equally to filters used with the funnel represented in Fig. 3.

The funnel represented in Fig. 4 may be used advantageously without the filter-pump, by attaching to the end *k* a vertical glass tube of small diameter. The contraction at the end *k* in this case becomes very useful, by allowing the filtered solution to collect before descending in the vertical tube so as to fill the tube. In this manner there is formed a vertical column which creates an aspiration, and gives quicker filtration than can be had with a common conical funnel. The washing of the precipitate is also more thorough, because all the water placed in the funnel has to go through the precipitate, while in the ordinary conical funnel a part passes off above the precipitate. For the same reason it is obvious that this funnel may be used as a percolator to exhaust porous materials of their soluble parts. The additional length obtained by connecting with a vertical tube would not be of any utility with a conical funnel, unless a platinum cone was used to support the apex of the filter, and at the same time the rest of its surface was pressed down tightly on the glass. Otherwise the air, entering freely around the filter, would not allow a column of liquid to form and to produce suction.

With the funnel represented in Fig. 4 very good results are obtained with tubes only fifteen inches long. Longer tubes act with greater energy, but are inconvenient to use.

471 Lafayette Avenue, Brooklyn, N. Y.,
May 6, 1875.

THE IRON ORES OF CERRO DEL MERCADO, NEAR DURANGO, MEXICO.

BY K. VON CHRUSTSCHOFF, PH.D.

The following is an extract from a "Monograph of the Cerro del Mercado," prepared by me during my residence in Durango, at the Iron Works "San Francisco," which will soon be published in full in the Journal of the German Geological Society.

The following ores constitute the mass of the iron mountain of Cerro del Mercado:—

1. *Magnetite.*—This ore forms the principal mass of the mountain, appearing especially on the ridges and peaks. It is of a black color, of a granular crystalline texture; the clefts and geodes are filled with groups of crystals, mostly octahedra with cubes, or combinations of the octahedra with rhombic dodecahedra and octahedral twins. The rounded masses of this ore which are scattered over the surface of the mountain and vicinity, become in time polished so that they resemble in some respects native metal. Very small particles of the ore possess very clearly magnetic properties. I have noticed that the intensity of the magnetism decreases with the fineness of the grain, and that the strongest magnets are more often found in cavities than in the homogeneous mass.

This magnetic iron ore occurs also in Sweden in large deposits. It is pure ferroso-ferric oxide, and furnishes up to 75 per cent. metallic iron. It is somewhat difficult of fusion, and in the pig is tough, yielding, however, iron having excellent properties.

2. *Hematite*, or ferric oxide, occurs in pockets on the west side of the mountain; it is partly compact, with a conchoidal structure, and consists partly of micaceous ore; in the latter case it can be regarded as homogeneous.

On the southwest side of the Cerro lies a hill in which the hematite occurs as an earthy substance, and is there called red ochre. 100 parts of this ore contain 30

parts oxygen and 70 parts iron. This earth requires less fuel than the former, and yields a pig excellent for the manufacture of steel; it is, therefore, generally preferred to the first named.

3. *Aluminous iron* is found on the southwest slope of the mountain; it is compact, of a brown color mixed with red; it contains ferric oxide, alumina, and some silicic anhydride. These constituents are so fusible that there is danger of the walls of the furnace being attacked.

4. *Silicious iron*, of a dark red color, accompanies the aluminous ore; it is chiefly a ferric silicate, and affords, with the before-named ore, an excellent flux, though it does not contain much of the metal.

5. *Limonite*, or ferric hydrate, forms pockets or veins, in the magnetic iron on the northern side of the mountain. Here also is found quartz, clay, gypsum, and phenacite. At one of these points, Jesus Maria y José, occurs alternately brown, reddish, blue, and black streaks, which last colors depend probably upon the manganese dioxide with which the ore is impregnated.

This ore is, on account of its impurities and earthy nature, less valuable for metallurgical purposes.

I found five analyses of the ore of Mercado of five samples taken in the year 1858, by the director of the works "San Francisco."

The analyses were made by A. H. Boye, of Philadelphia. In the following table his analyses and mine are arranged for comparison:—

	Boye's analysis.					Chrustschoff's analyses.				
	Magnetic ore.	Hematite.	Aluminous ore.	Silicious ore.	Limonite.	Magnetic ore.	Hematite.	Aluminous ore.	Silicious ore.	Limonite.
Ferric oxide	96·30	93·80	98·20	71·00	67·10	95·05	91·70	98·30	87·12	58·57
Manganic "	...	...	...	...	...	1·98	0·02	0·57	tr.	1·20
Alumina....	0·10	1·20	0·50	0·20	0·50	0·20	3·17	0·09	1 02	5·85
Silicic acid..	2·60	3·40	0·60	28·10	25·50	0·99	3·86	0·50	11·40	30·06
Calcic carb..	0·30	...	...	..	0·50	1·00	0·01	...	...	2·09
" sulph.	...	...	...	...	...	...	...	...	...	1·80
Water and loss.....	0·70	1·60	0·70	0·70	6·40	1·78	1·24	0·54	0·46	0·23
Total...	100	100	100	100	100	100	100	100	100	100
Metallic iron per cent.	66·77	65·30	68·80	49·23	50·55	Trace of tungsten and cobalt.				

All the other iron ores which generally occur in this connection are entirely wanting in Cerro del Mercado. To these belong the hydrate or yellow ochre and carbonate of iron, nor are the sulphides or phosphates of iron found here.*

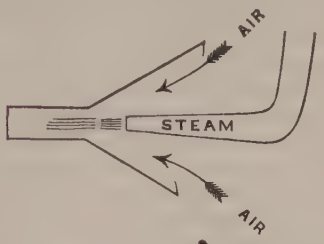
NEW YORK, May, 1875.

DECOMPOSITION OF COMMON SALT BY STEAM.

BY S. CABOT, JR.

Anxious to prove or disprove the much questioned fact of the decomposition of chloride of sodium by superheated steam, the writer instituted the following experiment:—

A fire was made in a cast-iron stove so arranged that all the doors and flues could be tightly closed and the air supplied through a tube at the bottom, while the products of the reaction (*with* the products of combustion) could be collected from a tube at the top.



Through the lower tube a blast of air mixed with steam was blown into the already hot fire, and through the top about a pound of salt was introduced.

Volumes of hydrochloric acid mixed with steam streamed from the upper tube, which easily condensed in a vessel partly filled with water.

The fire was kindled without the use of wood, to avoid the presence of alkaline matters in the ash, and yet the ash gave an alkaline reaction, as should be the case if the reaction is the simple one.

$$H_2O + 2NaCl = 2HCl + Na_2O.$$

The injection used for the blast of mixed air and steam was a simple tin funnel, with a fine jet of 30 or 40 pounds of steam inserted into it nearly to the apex. The writer believes that such a blast carried through a sufficiently long tube would be so freed from water as to form a very efficient supply for small blast operations.

The amounts of hydrochloric acid obtained in this reaction were too large to have been the result of any impurities in the coal, such as sulphur acting upon the sodic chloride, which might, of course, occur as in the Hargreave's process of decomposing salt by the direct action of air, steam, and sulphurous acid.

BOSTON, 11 Park Square.

PRICES OF METALS.

BY H. C. BOLTON, PH.D.

A paragraph bearing the above title has of late circulated extensively among scientific and pseudo-scientific papers, the origin of which we have been unable to trace. The paragraph referred to gives the price per pound avoirdupois of twenty-eight metals, beginning with indium, which is valued at $2520 per pound, followed by vanadium, ruthenium, etc., and terminating, of course, with iron. As it has reached us no authorities for the prices are given, nor is any statement made as to the sources of the information communicated.

The table abounds in gross errors, which has induced me to recalculate the prices, and at the same time to extend the list. Of course the prices vary considerably according to the dealer and the country, whether

* For the translation I am indebted to Dr. H. C. Bolton.

Europe or America. The prices of many of the dearest may be considered also as "fancy prices," and actually a whole pound of some of the metals named could hardly be obtained at even the extravagant figures annexed. In compiling the following table we have taken the prices of the rarer metals from Trommsdorff's and Schuchardt's last price-lists; we have assumed the avoirdupois pound as equal to 453 grammes, and the *mark* as equal to 24 cents gold.

An inspection of the table is not without interest; it is evident that the prices of the metals bear no relation to the rarity of the bodies whence they may be derived, for calcium, the third in the list, is one of the most abundant elements. Even that excessively sparingly distributed metal indium, the most recently discovered element, stands tenth in the list, below strontium. The metals of the alkalies seem to occupy a remarkably low place in the table.

S. and T. annexed to the price per gramme stands for Schuchardt and Trommsdorff respectively, and indicate the source of the data.

Metal.	State.	Value in gold per lb. avoirdupois.	Price in gold per gramme.	Author-ity.
Vanadium,	cryst. fused,	$4792·40	$10·80	S.
Rubidium,	wire,	3261·60	7·20	S.
Calcium,	electrolytic,	2446·20	5·40	S.
Tantalum,	pure,	2446·20	5·40	S
Cerium,	fused globules,	2446·20	5·40	S.
Lithium,	globules,	2228·76	4·92	S.
Lithium,	wire,	2935·44	6·48	S.
Erbium,	fused,	1671·57	3·96	S.
Didymium,	"	1630·08	3·60	S.
Strontium,	electrolytic,	1576·44	3·48	S.
Indium,	pure,	1522 08	3·36	T.
Ruthenium,		1304 64	2·88	T.
Columbium,	fused,	1250·28	2·76	S.
Rhodium,		1032·84	2·28	T.
Barium,	electrolytic,	924·12	2·04	S.
Thallium,		738·39	1·63	T.
Osmium,		652·32	1·44	T.
Palladium,		498·30	1·10	T.
Iridium,		466·59	1·03	T.
Uranium,		434·88	·96	T.
Gold,		299·72		
Titanium,	fused,	239·80	·52	
Tellurium,	"	196·20	·43	
Chromium,	"	196·20	·43	
Platinum,	"	122·31	·27	
Manganese,	"	108·72	·24	T.
Molybdenum,		54·34	·12	T.
Magnesium,	wire and tape,	45·30	·10	T.
Potassium,	globules,	22·65	·05	T.
Silver,		18·60		
Aluminium,	bar,	16·30	·036	S.
Cobalt,	cubes,	12·68	·028	S.
Nickel,	"	3·80	·008	T.
Cadmium,		3·26	·007	T.
Sodium,		3·26	·007	T.
Bismuth,	crude,	1·95	·0043	S.
Mercury,		1·00		
Antimony,		·36		T.
Tin,		·25	Prices taken from recent quotations.	
Copper,		·22		
Arsenic,		·15		
Zinc,		·10		
Lead,		·06		
Iron,		·01½		

METROPOLITAN GAS SUPPLY.

Dr. Letheby the chief gas examiner under the Board of Trade, has recently reported to the corporation of the city of London, and to the Metropolitan Board of Works, the results of the daily testing of the gas supplied to London by the Chartered, the Imperial, and the South Metropolitan Gas Companies, during the quarter which ended on the 31st of March last. At present there are nine testing places where the gas from the several works of these companies are daily tested by the officers appointed by the corporation and the Metropolitan Board of Works, and the average results of the *testing* during the quarter have been as follows:—

1*st. With respect to Illuminating Power.*—The common gas, when burnt at the rate of five cubic feet an hour from a Sugg's London Argand Burner, No. 1, with a six-inch chimney, has, in the case of the Chartered Company, averaged the light of 17·37 standard sperm candles at Beckton, 16·86 candles at Friendly Place Bow, and 16·92 candles at Ladbroke Grove, Nottinghill; while that of the Imperial Company has been equal to 16·17 candles at Carlyle Square, Chelsea, 16·04 candles at Camden Street, Camden Town, 16·93 candles at Graham Road, Dulston, and 16·22 candles at Bruce Terrace, Bromley. The gas of the South Metropolitan Company at Hill Street, Peckham, has been 15·94 standard sperm candles; and the cannel gas of the Chartered Company at Millbank Street, Westminster, has with a Sugg's Steatite Bat's-wing Burner, No. 7, burning at the rate of five feet an hour, given the light of 20·96 standard sperm candles. These results show that the illuminating power of the gas at each of the testing places has been fully equal to the requirements of the acts of Parliament by which the companies are regulated.

2*d. As regards Purity.*—The gas of all the companies has been constantly free from sulphuretted hydrogen, and the average amounts of sulphur in other forms than this have been as follows: In the chartered gas at Beckton, 10·97 grains per 100 cubic feet of gas; at Friendly Place, 13·18 grains; at Ladbroke Grove, 19·40 grains; at Millbank, 17·63 grains. In the gas of the Imperial Company the proportions of sulphur have been 17·49 grains per 100 feet at Carlyle Square; 15·10 grains at Camden Street; 16·18 at Graham Road; and 10·89 grains at Bruce Terrace; while that of the South Metropolitan Company has been 18·33 grains per 100 feet. Dr. Letheby reports that the proportion of sulphur in the gas has exceeded the prescribed quantity on four occasions at Ladbroke Grove, on four occasions at Bruce Terrace, and on three occasions at Hill Street, Peckham. The excess at Bruce Terrace is reported to have resulted from accidental and unavoidable causes. Ammonia has been at all times absent from the gas of the Imperial Company at Bruce Terrace, Bromley, and the maximum amount in the same company's gas at Graham Road, Dalton, was only two-tenths of a grain per 100 cubic feet. At Carlyle Square it was 0·7 of a grain,

and at Camden Street 1·5 grains. In the Chartered Company's gas the maximum amount at Ladbroke Grove was only 0·4 of a grain per 100 feet; at Milbank 0·5 of a grain; at Friendly Place 2 grains, and at Berkton 3·8 grains. On two occasions the ammonia in the gas at the last-named testing place exceeded the prescribed quantity of 2·5 grains per 100 cubic feet. The maximum amount of ammonia in the gas of the South Metropolitan Company was 1·6 grains per 100 feet.

ESTIMATION OF CAFFEIN IN TEA.

Translated for the Am. Chemist, from Die Chemische Werthbestimmung einiger starkwirkender Droguen, etc., von Dr. G. Dragendorff, by J. M. Merrick, B.Sc.

The quantitative estimation of caffein in tea is well accomplished by a method whose outlines were sketched by Mulder, but the practical application of which has been confirmed by the researches of Würthner and Weyrich, made in my laboratory. Five to fifteen grammes of tea are taken, exhausted with distilled water at 100°, the extract filtered and evaporated to dryness with the addition of 2 grammes of calcined magnesia and 5 of powdered glass. The finely powdered residue is put in a flask, covered with 60 c. c. of ether, digested 24 hours and filtered. The extraction with ether is repeated three or four times, so long as anything is taken up, and the united ethereal extracts are distilled from a flask previously weighed. The distillation flask containing the residual alkaloid, generally perfectly colorless, is dried at 100°, until it no longer loses weight. The increase in weight corresponds to the amount of caffein present, since the base, under these conditions, remains anhydrous. An essential point is to be liberal in the use of the ether, as caffein is not very easily soluble in this menstruum. Exhaustion can, however, as Würthner has shown, be perfectly accomplished. The mass that has been exhausted with ether gives up nothing to chloroform. Chloroform can be employed in place of ether, and with this the residue is more easily washed out, but the caffein isolated is not so pure. I have found judicious a mixture of one part chloroform and three of ether.

In the extraction of guaranna the addition of sulphuric or phosphoric acid is not necessary, and even does more harm than in the case of tea, since it breaks up the tannic acid, and sets free a decomposition product soluble in the ether and chloroform. [In three experiments with pure water, with water containing sulphuric and phosphoric acid, using in each case ·183 grm. of pure anhydrous caffein, Würthner obtained ·181, ·180, and ·181 grm. Long boiling with acidulated water occasions a loss in alkaloid. Würthner thus obtained from a certain tea, with pure water, 1·53 per cent., with water containing phosphoric acid 1·46 per cent., and with water containing sulphuric acid 1·269 per cent.] I found in two parallel experiments each with 10 grms. guaranna, using in the first pure water, and in the second water containing phosphoric acid, ·1565 grm. of a perfectly colorless, well-crystallized caffein, and ·4024 grm. of a brown resinous residue, showing no signs of crystallization. There are, however, richer sorts of coffee. For example, Stenhouse found in one kind about 5 per cent. of caffein; Würthner 1·1 per cent., etc. In the investigation of coffee Weyrich and myself have found it needful to pulverize as finely as possible the berries, previously dried at 100°, and to boil this powder with water a considerable time, the water being changed so long as it takes up anything. The decoction of coffee is filtered through a fine linen cloth. These extracts generally filter very well, certain kinds of green tea, which are (in extract form) slimy and apparently adulterated, making an exception.

Würthner has shown that to treat the pulverized tea, according to Leventhal, directly with boiling chloroform and from the residue of the evaporated chloroform extract to wash out the caffein with water in order to weigh the residue left on evaporating the aqueous extract, is untrustworthy, since hardly half the caffein is thus obtained. The method commended by Claus I do not consider so good as the one I have set forth above. He extracts directly with ether, shakes the extract with water containing sulphuric acid, evaporates the water to dryness, with the addition of calcined magnesia, and exhausts again with ether. The residue of the last extraction is weighed as caffein.

I have to object to this process that, 1. The direct treatment of tea leaves, etc., with ether hardly brings all the caffein into solution, and 2. That by shaking the ethereal extract with acidulated water the caffein does not all go over into the latter. Weyrich has further given us a means of controlling Zollners' method. Zollner warms the powdered tea with only slightly diluted sulphuric acid. After a while this is thinned with water, neutralized with hydrated oxide of lead, and filtered. The dried and powdered residue is exhausted with alcohol of 85°.

After this extract again has been brought to dryness the caffein is taken up with ether or chloroform. In the alkaloidal residue which Weyrich obtained was hardly any pure caffein (scarcely ⅓ of the total weight), and from this residue the base itself could not be obtained by means of water in a state of satisfactory purity.

Claus has decided unfavorably in regard to the method recommended by Peligot, and Weyrich has obtained by it no useful results. He precipitates the tea infusion with some basic acetate of lead and ammonia, removes the excess of lead from the filtrate by sulphydric acid, and evaporates to a small mass, out of which a part of the caffein crystallizes on cooling. The remainder of the alkaloid (left in the mother liquor) is determined by means of a solution of tannin. Crystallization can be carried out only when a considerable amount of tea is operated upon. In titrating with tannic acid not only the caffein, but other foreign substances seem to be precipitated, and the action of tannin in such extracts must be different from its action upon aqueous solutions of caffein. Weyrich found, in a variety of tea whose true percentage of caffein was 1·53, by Peligot's process 2·25 per cent.

An alkaloid determination in tea and coffee serves only to prove an admixture with already exhausted or foreign substances, but does not serve to distinguish a better from a poorer sort.

I give in the form of a table the composition of various kinds of tea occurring in Russian commerce, the analyses of which were made by Weyrich and myself.

	Varieties of tea.	Price per lb. Rubles and Kopeks.	Percentage water.	Constituents soluble in water.	Per cent. caffein in undried tea.	Per cent. nitrogen.	Per cent. slimy matter.	Tannic and boheic acid.	Constituents insol. in water.	Ash.	SiO_2 and sand.	Ash est. on tea free from sand.	Per cent. ash in insol. matter.	Per cent. ash in the sand free insol. constituents.	Per cent. potash in the tea.	Per cent. potash in the ash.	Per cent. potash in the sand free ash.	Per cent. P_2O_5 in tea.	Per cent. P_2O_5 in total ash.	Per cent. P_2O_5 in the sand free, total ash.	Per cent. P_2O_5 in the insol. constituents.	Per cent. P_2O_5 in the insol. const. reckoned on the sand free, total ash.	Remarks.
1	Yellow tea.	3·	10·90	35·5	1·78	6·72	...	...	53·6	5·92	1·64	5·28	2·16	1·42	2·53	42·82	47·91	1·09	18·47	18·59	·56	10·60	Length of leaves 25–47 mm. Only a few expanded leaves. Buds of 8 mm. diameter.
2	" "	5·	7·10	41·1	1·61	...	...	...	51·8	6·12	·35	5·77	1·99	1·64	...	...	...	...	...	...	·53	9·18	Length of leaves 30–40 mm.
3	" "	6·	9·09	38·8	1·44	...	...	...	52·2	5·61	·27	5·34	2·12	1·85	...	...	...	·80	16·65	16·69	·64	11·98	Very many petioles with crumpled, undeveloped leaves. Leaves 21 mm. long. Buds 3–5 mm. diam.
4	" "	8·	9·88	36·5	1·43	6·60	5·32	12.70	53·7	5·33	·85	4·48	2·79	1·84	2·10	39·55	46·87	1·33	25·02	25·23	·61	13·61	Buds and leaf stalks less developed. Few expanded leaves.
5	Green tea.	2·50	8·35	33·5	1·82	6.02	...	...	58·2	6·82	·85	5·97	2·74	1·89	2·27	33·40	38·02	·79	11·65	11·74	·32	5·36	Full-grown, but not leathery leaves. Moist, and as it seemed purposely halved. No buds. 5. Firmer than the rest, blue and less rolled. 6. Consists of pellets. 7. Of rolled cylinders.
6	" "	3·00	8·82	39·9	1·66	...	6·40	12·32	51·3	6·21	·98	5·23	2·50	1·52	...	...	...	·72	11·67	11·77	·47	8·98	
7	" "	4·50	7·92	37·5	1·61	6·01	...	...	54·6	5·78	·58	5·20	2·04	1·46	2·48	42·99	47·69	·77	13·32	13·39	·36	6.92	
8	Black tea.	1·20	10·63	44·5	1·36	4·15	...	...	44·9	6·07	·99	5·08	2·89	1·90	2·23	36·88	43·89	·79	13·11	13·24	·27	7·28	Full-grown, very much crumpled leaves.
9	" "	1·40	10·25	32·4	1·79	...	...	...	57·4	6·51	·83	5·68	3·68	2·85	...	...	...	·93	14·30	14·41	·30	5·28	Mostly full-grown, less crumpled, divided leaves. 11 and 12 less firm than the rest, so that after half an hour's warming with water they tore easily under the pressure of a glass rod.
10	" "	1·60	10·43	33·3	1·65	...	...	...	56·3	6·	1·35	4·65	3·75	2·40	...	...	...	·83	13·84	14·02	·32	6·88	
11	" "	1·75	9·98	26·8	1·89	...	...	...	63·3	6·22	·89	5·24	3·04	2·06	...	...	...	...	...	...	·37	7·06	
12	" "	2·00	9·47	30·7	2·08	...	5·32	9·42	59·9	5·62	1·19	4·43	3·19	2·00	...	...	...	1·03	18·42	18·64	·35	7·90	
13	" "	2·20	10·70	27·2	2·11	...	...	...	62·1	6·18	1·11	5·70	...	...	...	...	...	1·14	18·54	18·74	·35	6·90	Mostly not fully grown. Divided. Less firm leaves.
14	" "	2·50	10·90	27·2	2·14	5·26	...	...	61·9	5·78	·98	4·80	2·79	1·81	1·97	34·19	41·04	1·11	17·25	17·42	·42	8·75	
15	Blossom tea (Blumen Thee)	2·20	9·46	29.1	2·12	...	...	...	67·5	6·15	1·03	5·12	2·69	1·66	2·28	37·94	44·53	·88	14·42	14·56	·41	8·00	Mostly not perfectly grown leaves like 13 and 14. Leaf stalks intermixed as 3 and 4 with 16. More abundant than 15.
16	Blossom tea.	2·50	8·79	29·4	2·13	4·75	...	...	61·3	5·89	1·12	4·77	3·15	4·03	...	...	...	·87	14·79	14·95	·40	8·38	
17	" "	2·70	10·51	24·8	1·81	...	...	...	60·1	5·62	·92	4·70	2·32	1·40	...	...	...	1·27	19·92	20·10	...	...	
18	" "	3·00	12·66	30·5	1·79	...	...	...	62·6	5·66	·83	4·83	2·47	1·64	...	...	...	·94	16·71	16·84	...	...	Half developed leaves, some buds and leaf stalks.
19	" "	3·20	12·00	31·2	1·95	...	...	...	61·3	6·20	·97	5·23	2·47	1·50	...	...	...	1·04	16·88	17·04	·44	8·41	
20	" "	2·50	11·09	31·9	1·79	...	...	...	58·5	6·57	·97	5·60	2·45	1·48	...	...	...	·94	14·43	14·57	·43	7·67	
21	" "	4·00	10·36	31·2	2·02	...	...	...	58·5	5·45	·89	4·56	2·38	1·49	...	...	...	1·24	22·83	23·03	·42	9.21	Only young, part grown leaves, without buds. 23. Far from half grown. 21. Hardly half.
22	" "	5·	10·72	31·9	2·68	...	5·88	11·24	57·4	5·48	·73	4·75	2·04	1·31	...	...	...	1·27	23·19	23·36	·46	9·68	
23	" "	7·	11·05	32·8	3·09	5·19	...	...	57·2	5·83	·54	5·29	1·99	1·45	2·23	38·24	42·11	1·56	25·64	25·77	·54	10·20	

ON THE DISTRIBUTION OF SUGAR AND MINERAL CONSTITUENTS IN THE BEET ROOT (EXTRACT BY THE AUTHOR).

BY M. CH. VIOLETTE.

Translated by Charles A. Pitkin, A. B., from Les Comptes Rendus.

Conclusions.—1. Contrary to the generally received opinion, the amount of sugar in the sacchariferous and cellular tissue of the beet root differs but little.

2. The amonnt of sugar increases appreciably in arithmetical progression, following the axis of the beet root from the neck to the extremity of the root.

3. The mineral matter does not show this regular variation, following the axis of the beet root, but, according to M. Peligot, the chlorides are more abundant at the neck than near the end of the root. I shall add to this, that the proportion of chlorides follows a decreasing arithmetical progression from the neck to the extremity.

4. The proportion of mineral matter is considerably greater in the cellular tissue than in the sacchariferous.

5. The proportion of chlorides is considerably greater in the cellular tissue than in the sacchariferous. It varies from three to eight times as much. This fact leads to the following important results :—

The explanation of errors in the process of treatment of natural sugar.

The explanation of the abundance of chlorides noticed by M. Peligot in the upper part of the beet root. It gives a distinct idea of the vegetation of the beet root, and of the unequal distribution of the mineral and organic constituents following the laws of osmose. It furnishes to the sugar industry a practical process for the choice of seeds, and using close-grained seed-plots as suggested by M. Despretz some fifteen years ago.

6. Most of the mineral constituents undergo variations in the two sorts of tissue, but less than the chlorides.

A NEW METHOD FOR THE VOLUMETRIC DETERMINATION OF ZINC.

BY C. FAHLBERG.

Translated by Charles A. Schaeffer, Ph.D.

Although very many methods have been proposed for the determination of zinc in the ores of that metal, the gravimetric method is still the one that is most generally employed. The reason of this seems to be that none of the volumetric determinations give the amount of zinc with sufficient accuracy in the presence of another metal of the iron and alumina group.

The sulphide of sodium method, long since modified by Schaffner and more recently by Künzel, as used at the Belgian zinc works, is also defective in that it cannot be used in presencc of aluminum and manganese. Moreover, the sulphide of sodium solution is not very permanent, and its oxidation to sodic sulphate cannot be prevented even with the utmost precaution and by the use of potassic pyrogallate to exclude the air.

Mohr's method, with potassic ferricyanide and iodide, where the separated iodine is titrated with sodic hyposulphite, is also deserving of mention, but for technical purposes it is too expensive, and besides cannot be used when manganese is present.

In most cases it would make very little difference if the small amount of manganese were determined with the zinc, since it never exceeds 1·5 per cent. If, however, a method should be found by which this objection could be obviated, the process being at the same time a rapid one, it would, without doubt, very quickly supplant the old time-consuming gravimetric method.

I believe that I have made at least an approach to the fulfilment of these conditions by titrating with potassic ferrocyanide the hydrochloric acid solution of zinc in the presence of aluminum and manganese. The ferrocyanide of zinc is insoluble in hydrochloric acid; the ferrocyanide of manganese is soluble, and alumina gives no reaction with potassic ferrocyanide. Such being the case then when a solution of potassic ferrocyanide is added to a solution of chloride of zinc containing manganese and alumina, the ferrocyanide of zinc alone is precipitated, and the few drops in excess of the normal solution can readily be determined by means of a salt of uranium, which may be taken as an indicator. Even if the excess had caused the formation of the ferrocyanide of manganese, owing to its solubility, the resulting brown coloration with a drop of the uranium solution would be as readily perceived. If the formation of ferrocyanide of manganese had been begun while yet zinc remained in solution, it would inevitably be decomposed and insoluble ferrocyanide of zinc result, in accordance with the fact proven by me that ferrocyanide of manganese dissolved in hydrochloric acid gives with a soluble zinc salt the ferrocyanide of that metal, which is insoluble is hydrochloric acid.

In the presence of nickel and cobalt this method is not applicable, since both of these metals in hydrochloric acid solution give insoluble precipitates with alkaline ferrocyanides. When present in very small quantities, however, as is the case in the lower Hartz ores, nickel and cobalt may very well be entirely neglected. It is a matter of great satisfaction that we have been able in my laboratory to make very frequent determinations of zinc ores containing manganese without having recourse to the very tedious gravimetric method, and that too within a limit of error of, at most, 0·2 per cent.

The normal solution of potassic ferrocyanide I usually prepare so that 1 c. c. corresponds to 0·01 gramme zinc, and for this purpose it is first titrated with a solution of the pure zinc from de Haen in Hanover. The metal is first dissolved in hydrochloric acid, and to the solution ammonic chloride to the extent of five times the weight of the metal is added, so as to obtain the flakes of the precipitate as fine as possible, that they may not while settling to the bottom mechanically inclose the potassic ferrocyanide. In this way about 0·5 gramme zinc is to be prepared, and the titration performed with a burette provided with a good glass stopper and divided into $\frac{1}{10}$ c. c. At first large flakes are obtained, but as the operation proceeds they constantly grow finer. After each addition of the ferrocyanide a drop is to be taken from the beaker and tested with solution of nitrate of uranium, to ascertain whether the whole of the zinc has been converted to ferrocyanide and an excess of the normal solution added. For this purpose I use a porcelain slab, which is previously moistened with a row of drops of the uranium solution. To these drops I add in succession after each addition of the normal solution a drop of the solution in course of determination; towards the close, after every five drops of normal solution As long as zinc remains in solution only the white flakes of the ferrocyanide of zinc are seen on the slab, but on the addition of only a very few drops in excess a permanent brown spot is obtained. With

careful manipulation the greatest possible error is 0·2–0·3 per cent., but even this could be diminished by one-half by the use of a normal solution of half strength. My experiments have shown, however, that this only results in tedious and unnecessary work. With patient and careful working it will be found that the solution of which 1 c. c. is equivalent to 0·01 gramme zinc gives sufficiently accurate results. The indicator is exceedingly sharp, as is shown in the reverse method, for titration of phosphoric acid according to Neubauer.

For the determination of zinc in its ores I dissolve them with nitric and hydrochloric acids, add an excess of the latter, and treat with a current of hydrosulphuric acid to remove the metals of the 5th and 6th groups. After filtering the iron is oxidized with nitric acid, and when cold precipitated with ammonic hydrate, the zinc remaining in solution. If the iron should be found to contain zinc it must be dissolved in hydrochloric acid and reprecipitated. The two filtrates are then to be added to each other for titration. This ammoniacal solution is neutralized with hydrochloric acid, and further 10–15 c. c. acid sp. gr. 1·12 is added, and the titration with the ferrocyanide solution can then be made.

The following determinations of ores from the Rammelsberg will serve to show the accuracy of my results:—

	Potassic Ferrocyanide method. Per ct.	Gravimetric method. Per ct.
Rich copper ore	6·94	7·09
Ordinary copper ore	3·06	3·18
" "	3·57	3·90
Poor copper ore	3·90	3·80
Mixed ore	10·19	9·98
"	17·72	17·34
"	12·64	12·94
Lead ore	22·70	22·92
"	20·01	20·31
"	19·77	19·28
"	17·35	17·74

I believe that this method has many advantages over all volumetric methods hitherto practised. It offers the advantages of rapidity and accuracy to any one who has to make 10–15 zinc determinations in a day. Furthermore, the preparation of the sodic sulphide solution is tedious and disagreeable, while potassic ferrocyanide is a substance which can always readily be procured in a pure condition.—*Fres. Zeitsch.*, IV. Hft., 1874.

THE VARIOUS PREPARATIONS OF KOUMISS AND THEIR USE IN MEDICINE.*

BY V. A. JAGIELSKI, M.D. BERLIN,

Late Physician in the Prussian Army, etc.

Though authorities may differ on other points of the subject, they all unite in the opinion that chronic diseases, and especially those of a consumptive or emaciating nature, are developed by anti-hygienic influences. Logically, then, to combat these diseases, and to cure them, particularly in their early stages, they must be treated with means which will correct or arrest the morbific impulse. Primarily, the atmospheric conditions which surround the patient ought to be suitably chosen; and secondly, but no less urgently, the diet must be so regulated if possible, as to act the part of both "physic and food." In this relation, the practice of medicine is becoming more and more distinguished, in both its "science and humanity," by the importance which it now gives to dietetic remedies in therapeutics. We have in them facilities for the physiological and chemical treatment of certain obstinate diseases that resist purely remedial agents, and they are real handmaids of the greatest service to the practitioner. Chief of these remedies, and indeed, epitomizing them, is the milk of animals, because in its composition it comprises all the nutritive requirements of the body. Yet, perfect as milk is in all the elements of a facile alimentation, disease has oftentimes so enfeebled the digestive powers, that even it cannot be assimilated in sufficient quantity to maintain healthy life. Fortunately, however, there is a chemical sensitiveness in milk, which predisposes it to such physical and internal changes as will enable it to accomplish the prompt and perfect nutrition of the organism by overcoming the pathological obstacles. We have an example of this in the koumiss of the Tartars, which is fermenting mare's milk. Its magic effects are manifested in the robust constitution and the complexions of the nomadic people of the Russian Asiatic steppes, who during the warmer season live exclusively upon it, to recruit the health and strength which they have lost through the privations and exposures of the previous winter.

That milk will undergo vinous fermentation, and yield a certain quantity of alcohol, is not generally known. Every educated person, however, has heard that the Tartars drink the milk of their mares in a state of fermentation, called koumiss. Samara and Orenburg were the first places which were chosen for a resort of cure in chronic chest diseases. To Dr. Stahlberg belongs the great merit of inducing the Russian Government to assist him in opening the first koumiss institution in Moscow, and afterwards in Tsarskoe Silo, near Petersburg, the milk of mares being used which were expressly imported from the Tartar steppes; and it is from Vienna that we have heard recently of the great success of koumiss, introduced again by Dr. Stahlberg.

The milk of all animals is convertible into koumiss by one and the same method; but, as the several milks differ among themselves in the quantitative relation of their components, so also will there be corresponding variations in the koumiss which is produced from them. Qualitatively, however, the koumiss from different kinds of milk may be considered uniform, as has been shown in my special work on koumiss published in 1870, and in my paper in the *Milk Journal*, April, 1871. More immediately in connection with this paper, however, I present the analytical results of Wanklyn, obtained from cow's milk *medium koumiss*. A quart bottle of this medium or B koumiss* (manufactured in London, by E. Chapman and Co.), which holds about 12,000 grains of koumiss, contains as follows:—(It was examined when twelve days old; specific gravity, at 62° F., 1·028.)

Water	10,662 grains.
Alcohol	192 "
Casein and albumen	128 "
Lactose	582 "
Lactic acid	130 "
Fat	36 "
Ash	90 "
Carbonic acid	180 "
	12,000

*From the *British Medical Journal*, Feb. 21st, 1874.

*This analysis is not contained in J. A. Wanklyn's book on *Milk analysis* published by Trübner and Co., 1874, which gives only "Full" Koumiss tables.

The 90 grains of ash contain, approximately, 60 grains of phosphate of lime and 30 grains of mixed chlorides of sodium and potassium.

The three gradations of koumiss, designated as Nos. 1, 2, and 3, represent the irrepressible changes which it undergoes in time, while fermentation continues in the bottles. In the process of conversion of the milk into koumiss, the following changes take place. By the interaction which is promoted, casein is set free, in a highly attenuated molecular condition. The lactose is partially converted into alcohol, carbonic and lactic acids; and incidentally a bouquet of fragrant volatile products is generated (according to Morfit), which may perhaps be regarded as adjuvant in the remedial effect of the koumiss. The fermentation, once started, will continue, no matter how cold the temperature, or how closely the koumiss may be corked in bottles. Thus, the products arise in time from the minimum in No. 1 to the maximum in No. 3. In passing through these gradations, the koumiss retains all its general properties, but changes some of its specific adaptations, as will be explained directly. In all cases, the koumiss is a milk-like fluid. In its fresh No. 1 state, it is a still liquor, and has an agreeable sweetly-acidulous taste, recalling sweet almonds. As it approaches the No. 2 gradation, it becomes more acidulous, assumes a sparkling character, and requires to be drawn from the bottle through a special tap. In No. 3, the sweet taste is replaced wholly by the acidulous, which also has sometimes a slight shade of bitterness; and the koumiss not only sparkles, but rushes through the tap in a rich creamy foam. These changes progress so rapidly in warm weather, that the bottles should be kept in a cold cellar, and treated with the same care as champagne wine. The distinctive character of koumiss is that of being the most assimilable of nutriments. Every quart bottle contains, approximately, 970 grains of solid respiratory and plastic food, according to Wanklyn, and each of its elements is in a state to promote digestion of the others by the feeblest stomach.

The original koumiss of the Tartars is made from mare's milk; but, in my judgment, cow's milk is an equally good raw material, if not better; and there is no doubt that this koumiss gives highly successful results in proper cases, as shown here, in Odessa, Warsaw, Cracow, etc. It is not thin like mare's milk; and besides, it gives a koumiss free from every disagreeable odor and taste. Moreover, cow's milk, by its composition, affords facility for varying the composition and consistence of the koumiss-product according to the indications of particular cases. This is an important consideration, as through its means the chemist is enabled by his proper skill to make full koumiss, pure whey koumiss, medium koumiss, and extra kinds of special composition for special diseases, like diabetic koumiss, etc.

The physical and chemical characteristics of koumiss render it an aid upon which we can rely with great confidence for the treatment of extreme debility and all the phases of impending marasmus. A long and favorable experience justifies me in giving an empathic assurance on this point. Koumiss not only contains a large proportion of lactic acid, which is a prime constituent of the gastric juice, but holds the casein in that state of vitality which gives it the property of metamorphosing itself and the other constituents of the milk into healthy lymph and blood.

The physiological features of the several constituents of koumiss may shortly be specified as follows:—

The *lactic acid* activates the digestive powers, diminishes the temperature and the frequency of the pulse, and regulates the mucous secretion. It has an additional specific action in certain diseases, as, for instance, in diabetes.

The *casein*, *albumen*, and *fat* restore the plastic and heat-giving materials of the body, and act as a chemical inspiration, so to speak, to promote assimilation of its associate constituents.

The *lactose* increases the weight of the body and gives heat.

The *alcohol* produces sleep, diminishes heat, and forms fat.

The *carbonic acid* allays nausea, calms gastric irritation, augments diuresis, increases the energy of the heart's impulse, and diminishes the frequency of the heart's contractions.

As to the more minute acids and fragrant compounds, I prefer not to speak until my experience and observations in regard to them have become more mature.

It will thus be seen that the process of double fermentation in the artificial preparation of cow's koumiss has done nearly all the preliminary work which would fall otherwise on the digestive organs. There is no other derivative of milk or any other substance which can be substituted for it with corresponding advantages, for it may constitute a sole diet, as my own experience has proved, in many cases of chronic dyspepsia, both simple and complicated. Dr. Braczinski of Berlin speaks in his monograph of koumiss from cow's milk as one of the most valuable aids in the medical practice of Warsaw; and Dr. Neugebauer of Warsaw makes a special mention of a case, in his private practice, of a young nobleman, presenting all the symptoms of tabes dorsalis, which was entirely cured in six weeks by treatment with cow's milk koumiss. This confirms my own experience with a mild case of a similar kind. Dr. Küttner, in Dresden, has also reported to me many gratifying results which he has obtained with koumiss in dyspepsia and dibility. Dr. With of Brunerhaven writes in strong favour of fresh koumiss for all catarrhal diseases of the stomach, bowels, lungs, and in anæmia. In Dr. Kwasnicki's Polish translation of my treatise on koumiss (1870), there is a note which records Dr. Nowakowski's and Dr. Przystanski's confirmation of my own experience in the use of cow's koumiss. An appendix to the same translation gives the clinical experience of Professor Chalubinski at the University of medicine in Warsaw, which prompts him to recommend earnestly the use of cow's koumiss in catarrhal disease of the mucous membranes of the gastro-intestinal and respiratory tractus, and in debility from whatever cause. Dr. Edward Charlton, the late Surgeon-Major Ross, and Dr. R. Dawson, have also written to me in praise of koumiss as a valuable dietetic remedy, and Dr. Campbell Morfit, of the U. S. A., found, in his own case, that the British koumiss acts with the most decided benefit in catarrhal diseases and obstinate constipation, and increases weight rapidly. Mr. Ceely of Aylesbury, and many other brethren in this country, share the same opinion as those whose families I had the pleasure of advising. Neftel, Stahlberg, Schnepp, Marra, Weinberg, etc., have contributed largely to the medical literature of this subject, which has in the last few years increased considerably, as I presently count over thirty authors, who all agree on the main points of therapeutical success of koumiss, from whatever milk it may have been prepared. I will not prolong this paper by enumerating the cases reported in those works,

as I shall arrange them in a proper order in the second edition of my treatise on koumiss; but so much I must say, that all these authors confirm the brilliant therapeutical results described so well by the father of koumiss literature, Dr. John Grieve of Edinburgh, late physician to the Russian army, when his paper, written with emphasis and with an undeniable noble feeling throughout, was read by Dr. Black, July 12th, 1784, in Edinburgh, regretting that koumiss should still remain unknown in the most enlightened parts of Europe, although a horde of Tartars, etc., had been using it for some ages past. I only do my duty in paying the greatest possible respect to the memory of Dr. Grieve, because even to-day his correct conceptions, his skilled judgment, his well-defined indications, have not found a better and nobler expression on this subject after the lapse of almost a century, and I willingly indorse Virchow's words: "I have two faults over which I rejoice conscientiously: the one, that I consider the old physicians as 'brave' observers; and, perhaps the still greater one, of believing in their therapeutics."

Passing on to the indications of koumiss, I purposely omit to speak more specially of its physiological effects, which can only be understood by the full knowledge of its separate ingredients, and the operation of each; involving investigations that belong rather to a separate work, including the cumulative effects or sum total of the effects of koumiss.

Full Koumiss (A) is made from cow's milk, preserving the whole of the cheesy matter and as much of the butter or cream as is compatible with digestion and manufacture. It is adapted for cases of great emaciation with weakness of the digestive organs, when little liquid and no solid food can be taken; also for all complaints which are not of febrile character, the bodily temperature especially not exceeding 100 deg. Fahr.; and for patients who have previously improved under the use of *Medium Koumiss* (B). This is the artificial representant, as nearly as possible, of the mare's milk koumiss, not obtainable in this country; and can be made by mixing ass's milk with cow's milk in the proper proportions, or by adjusting the natural components of cow's milk alone, so as to diminish the casein and butter and augment the lactose and salts, thus making the koumiss more facile of digestion. It is suited to delicate or sensitive stomachs, which revolt against the buttermilk taste of the full or A koumiss, in which the cheesy matter proves too rich; and is also a more sensitive koumiss, of more agreeable taste, so as even to satisfy a very capricious palate. Should there be in some exceptional cases a dislike even to the B koumiss, then I would prescribe, especially for children or ladies, whey or C *Koumiss* No. 2 or 3, mixed with one-third part of fresh milk, warmed, if wanted, at the time of drinking, to be taken at first in small doses frequently during the day (one pint bottle *per diem*), increasing every two days *usque ad libitum* (three or four pints and more per day). Some persons, again, will prefer a little sugar dissolved in a tablespoonful of warm water put first into the tumbler, then the fresh milk, and on this let the koumiss out with all its force to mix thoroughly. A small quantity of champagne wine with it will augment the alcohol in a very pleasant way, if necessary.

The specific gravity of B koumiss varies between 1035 and 1070 in its fresh state, though, by the process of fermentation, it may sink below 1028 in consequence of the lactose breaking up into lactic and carbonic acids and alcohol. It may be used for diseases of the stomach and lungs instead of solid food, especially when the patient frequently asks for an acidulous drink, which in this case will not raise the temperature or irritate the stomach by a too sudden ingestion of solid matter. In this koumiss, it is also found that, in the second stage of fermentation, the cheesy matter appears in separate layers, which, however, by shaking, can be easily reduced to a homogeneous milky fluid by combining with the serous layers, and the molecular condition is then so uniform that no flakes are noticeable, as in the genuine mare's milk koumiss. I may notice here that cheesy matter in the solid form, separated from the milk by means of rennet, curds, etc., is quite indigestible, even in small quantities, and can only be adopted for food when fermented in the shape of Stilton or Cheshire cheeses, etc., which are prepared, with or without the addition of cream, all over the globe; whereas, in a well-fermented koumiss, the cheesy matter appears as a homogeneous, soft mass, which constantly develops bubbles as long as it is moist, and the flakes dissolve on the tongue like snow, with an acidulous and a pleasant sensation. No wonder, then, that it does not give the stomach the slightest trouble in digestion or absorption; and I can safely say that I have never found any other form of cheesy matter, by any course of preparation, that possessed similar properties, although I have made innumerable attempts to produce a soft cheese which would prove digestible in larger quantities, so as to replace loss of flesh in certain wasting diseases. In my experiments, I found that the dry residue of koumiss, after filtration or evaporation, affords a granular mass of acidulous taste, containing undecomposed lactose, albumen, and salts, which, when made into lozenges with the necessary additions, are so easy of digestion, that a few of my friends consumed nearly a pound of them after dinner—*pour la bonne bouche et digestion!* I would not seem, however, to recommend A koumiss after a hearty meal, though I shall never forget Plymouth, where, after reading my paper on koumiss, a very eminent gentleman contended in sober earnest that, having taken some of Chapman's Full Koumiss in the museum, for the supposed purpose of removing indigestion after a full breakfast that had disagreed with him, instead of feeling better he became worse, as if a "plenus venter digerat libenter" when it becomes still more extended.

I have been often called upon to answer most amusing questions with regard to koumiss, though I must confess I correct with the greatest pleasure the errors committed by others on the subject of milk-fermentation. Many look upon koumiss as a drug-medicine, and think that with one or two bottles, taking a tablespoonful every two hours, a decided effect ought to follow; just as some persons fancied that guano, when first introduced, would make plants grow *ad oculos demonstrandum* (before their own eyes!). I regret that the age of wonders has passed, although there is still a credulous portion of humanity to conjure up wonders in their own imagination. Koumiss is, however, undoubtedly entitled to be regarded as a medicine that "heals to nourish, and, in nourishing, gives strength and weight in the shortest possible time;" which is a truth daily confirmed in proper cases. In any case, this remedy is, at all events, harmless, occasioning no anxiety to the physician, and much more likely to produce the good effects he desires, especially in cases where drug-treatment is apt to fail. I ought to state that I never had the opportunity of procuring a sufficiently large quantity of mare's milk

for koumiss, so as to make fair trial of it in practice; and my conclusions as to the comparative merits of mare's and cow's milk koumiss are strictly of a deductive nature, based on the analysis.—*Pharm. Journ. and Trans.*

REPORT ON THE WATERS OF THE FLAX POND AND ITS TRIBUTARIES, THE PROPOSED SUPPLY FOR THE CITY OF CHELSEA, MASS.

BY WM. RIPLEY NICHOLS.

Edwin C. Barnes, Esq., *Chairman of Water Committee, Chelsea:*—

Dear Sir: Allow me to present the following results of the chemical examination of the waters which I received from your Engineer, Mr. Clemens Herschel, on the 10th inst.

The waters were allowed to stand 18 hours, in order to allow the suspended matter to deposit, and then examined. The results are expressed both in "grains per U. S. gallon of 231 cubic inches," and in "parts per 100,000," as practice in this matter is not uniform.

[Note.—The localities from which the waters were taken, and which were unknown to Professor Nichols, were as follows:—
No. 1. Flax pond Gate-house.
No. 2. Flax pond, near entrance of Sluice pond.
No. 3. Sluice pond, about 400 feet above the outlet.]

	No. 1.		No. 2.		No. 3.	
	Parts per 100,000.	Grains per U. S. gal.	Parts per 100,000.	Grains per U. S. gal.	Parts per 100,000.	Grains per U. S. gal.
Ammonia	0·0047	0·0027	0·0053	0·0031	0·0052	0·0031
"Albuminoid ammonia"	0·0122	0·0071	0·0109	0·0064	0·0117	0·0068
Inorganic matter	2·76	1·61	2·00	1·17	2·12	1·24
Organic and volatile	0·74	0·43	1·00	0·58	1·04	0·61
Total solid residue at 212°F	3·50	2·04	3·00	1·75	3·16	1·85
Chlorine	0·42	0.24	0·42	0·24	0·44	0·26
Silica	0·3937	0·2299	....	....	0.4137	0·2415
Oxide of iron and alumina	0·0887*	0·0518	....	....	0·0612†	0·0357
Lime	0·2862	0·1670	....	....	0·2662	0·1554
Magnesia	0·2329	0·1366	....	....	0·2459	0·1435
Sulphuric acid (SO_3)	0·1974	0·1150	....	....	0·2094	0·1222

The hardness of the three samples as estimated by the "soap-test" was the same, being equivalent to that caused by 0·58 grains of carbonate of lime to the gallon.

METHODS OF ANALYSIS.

1. *Total solid matter* left on evaporation. This residue was dried at the temperature of boiling water (212° F.) and weighed.

2. *Loss on burning* the solid residue at a low red heat. The solid matter left on evaporation is subjected to as low a heat as will suffice to destroy the organic matter, and burn the carbonaceous residue. The mineral matter remaining is moistened with water, saturated with carbonic acid, and again dried at 212° F. This loss is denominated "organic and volatile matter," and in case of river and pond waters of character like those examined, the loss is due almost entirely to the destruction of vegetable matter.

3. *Ammonia* and (4) "albuminoid ammonia." The water is first distilled with carbonate of soda, to remove the ammonia existing in the water ready formed; then with an alkaline solution of permanganate of potash, which, by acting on the *nitrogenous organic matter*, causes the evolution of an additional quantity of ammonia. Although the amount of these substances is usually very small, yet as they indicate the presence of nitrogenous organic matter, it is felt that even very small quantities render a water undesirable.

5. *Chlorine.* This substance exists mainly in the form of chloride of sodium (common salt). Although the compounds of chlorine thus formed in the water are not in themselves harmful, yet, with the exception of a small amount normally present in all natural waters, these compounds are derived from household and manufacturing operations, and the presence of any considerable amount of chlorine causes the water to be looked upon with suspicion.

How the waters under examination compare with Cochituate and Mystic waters may be seen by inspection of the following table:—

Results expressed in Parts per 100,000.

Date.	Description.	Ammonia.	"Albuminoid ammonia."	Inorganic.	Organic.	Total solid residue.	Chlorine.	Authority.
Dec. 10, '74.	No. 1 above	0·0047	0·0122	2·76	0·74	3·50	0·42	Dr. W.R. Nichols.
	" 2 "	0·0053	0·0109	2·00	1·00	3·00	0.42	" "
	" 3 "	0·0052	0·0117	2·12	1·04	3·16	0·44	" "
July 4, '73.	Cochituate water (drawn in Boston)	0·0033	0·0120	2·84	2·80	5·64	0·34	" "
Dec. 12, '74.	" "	0·0064	0·0153	2·20	1·72	3·92	0·44	" "
June 13, '73.	Up'r Mystic (av'ge of 4 determinations)	0·0134	0·0244	8·42	2·04	10·46	2.02	" "
Sept. 17, '74.	Mystic Lake (at gate house)	0·0084	0·0230	5·00	9·40	14·40	2·60	Dr. E. S. Wood.

GENERAL CHARACTER OF THE WATERS.

As shown by the preceding table, the three samples are very similar in chemical composition. They are all nearly colorless, and have the usual taste of pond water, somewhat insipid as compared with well or spring water. Qualitative examination shows no appreciable amount of nitrates, and the amounts of chlorine, ammonia, and albuminoid ammonia, as found above, show that the water, as far as chemical examination is concerned, is very suitable for domestic use. The water is also very soft, which is an important consideration for many household uses, although it is an open question whether for drinking purposes so soft a water possesses any advantages over one containing a moderate amount of lime compounds. The amount of suspended matter was very small; not enough to make its determination of any moment. Microscopic examination showed that it consisted in the main of vegetable debris, and that it was characterized chiefly by an almost complete absence of living microscopic growth; this, however, may be somewhat dependent on the season of the year.

As you wished me to investigate the action of the water on lead, I have done so with as much thoroughness as the time allowed.

Experiment No. 1.—Equal quantities (500 cubic centimetres) of the waters were put into separate flasks,

* Including a trace of phosphoric acid.
† Including a very faint trace of phosphoric acid.

and in each was immersed a strip of lead, exposing a surface of 6½ square inches to the action of the water. The flasks were then corked and allowed to remain undisturbed for a week. In the course of a day or two there began to be seen a growth of yellowish-white crystals of the hydrated oxycarbonate of lead, which formed as a very loosely adherent coating on the surface of the lead. At the end of a week the strips of lead were taken from the flasks, the loose coating washed off, and the amount of lead dissolved in the water was determined; also the amount contained in the flocculent solid oxycarbonate before alluded to.

No. 1. The amount of lead was:—

	Parts per 100,000.	Grains in U. S. gallon.
In suspension . .	9·578	5·591
In solution* . .	0·068	0·040
In all . . .	9·646	5·631

No. 2. The amount of lead was:—

	Parts per 100,000.	Grains in U. S. gallon.
In suspension . .	10·630	6·204
In solution* . .	0·068	0·040
In all . . .	10·698	6·244

No. 3. The amount of lead was:—

	Parts per 100,000.	Grains in U. S. gallon.
In suspension† . .	———	———
In solution . .	0·0956	0·0558
In all . . .		

After the removal of the loosely adhering coating of the oxycarbonate, the surface of the lead was found to be covered with a film of oxide not readily removed. The strips thus coated were replaced in the flasks and again covered with water as before. The lead has now been exposed to the action of the water for four days, and only very trifling amounts of the oxycarbonate of lead have formed; no doubt a certain amount is *dissolved* as before. Another set of three flasks filled at the same time as those examined, and which consequently have remained undisturbed for eleven days, do not apparently show any greater amount of the lead compound formed than they did a week ago, although, of course, the amount may have increased somewhat.

Experiment No. 2.—I took a coil of 100 feet of new ¼ inch lead-pipe and filled it with water No. 2. (As the waters were very similar, and as I understood that it was not a question of any *comparative* action on lead, I used No. 2 for this experiment, because I chanced to have the largest supply of this sample, after making the various analytical determinations.) The pipe held 64 cubic inches of water, and the surface of lead was equal to about 900 square inches. The water was allowed to remain in the pipe for 50 hours and then removed, a fresh supply being introduced without allowing the air to come into contact with the inside surface of the pipe. The water as drawn was quite turbid, from the presence of the oxycarbonate of lead, and was found to contain:—

	Metallic Lead. Parts per 100,000.	Grains in U. S. gallon.
In solution . .	0·055	0·032
In suspension . .	1·257	0·733
Total . . .	1·312	0·765

* As the amount of lead in solution was so small, the two portions of water No. 1 and No. 2 were mixed together. The amount seemed to be very nearly the same in each case.

† A mishap befell this determination, and time did not allow its repetition. The amount of suspended matter seemed to be a trifle less than in Nos. 1 and 2, but very nearly the same.

At the end of 70 hours the water in the pipe was drawn out and found to contain:—

	Metallic Lead. Parts per 100,000.	Grains in U. S. gallon.
In solution . .	0·573	0·334
In suspension . .	0·137	0·080
Total . . .	0·710	0·414

The pipe was then thoroughly washed from any loosely adhering coating by allowing a rapid stream of Cochituate water to flow through for some time. The Cochituate water was then displaced by water No. 2, and this water was allowed to remain in the pipe for 30 hours. This water when drawn contained both in solution and suspension 0·157 part of metallic lead in 100,000 or 0·092 grain to the U. S. gallon. The amount in suspension was not determined separately, as there was no very considerable quantity visible to the eye. A fresh portion of water was allowed to remain in the pipes for 40 hours, and then contained in solution and suspension 0·184 part in 100.000, or 0·107 grain to the U. S. gallon.

From these observations and determinations I conclude that the action of this water on lead will be very similar to that of Cochituate. When first introduced into new pipes, prudence demands that in drawing water for use, enough should be allowed to run to waste to *thoroughly* clear the pipes; in a very short time, however, the pipes will probably become coated, and the subsequent action of the water, although continuous, will be very slight; even then it is well (as is generally the case where lead pipes are in use) not to use, for drinking or for culinary purposes, water that has stood in the pipes for any considerable length of time, as, for instance, over night.

I append a few determinations which I made several years since for the State Board of Health, with reference to the amount of lead in Cochituate water under the ordinary conditions of its use.

AMOUNT OF LEAD IN COCHITUATE AND MYSTIC WATERS.*

No. 1. Water dipped from the upper part of Cochituate Lake in a glass jar, August 31st, 1870. 1000 c. c. of this water failed to give indications of the presence of lead.

No. 2. Water from one of the drinking-fountains on Boston Common, July 20th. 100,000 parts of this water contained 0·0415 part metallic lead, equivalent to 0·0242 grain to the U. S. gallon of 231 cubic inches.

No. 3. Water from private residence, No. 137 Walnut avenue, July 19th. The water is delivered through a hundred feet or more of tin-lined pipe, and then through 10 or 12 feet of lead pipe. The pipes have been in use some six months. 100,000 parts of the water contained 0·0342 part of metallic lead, equivalent to 0·0290 grain to the gallon.

No. 4. Water from hot-water pipes of same dwelling-house as No. 3, July 21st. This water passes through 40 additional feet of lead pipe, through a lead-lined tank, and through an ordinary copper boiler. 100,000 parts of this water gave 0·191 part metallic lead, equivalent to 0·112 grain to the gallon.

No. 5. Water from the Chemical Laboratory of the Massachusetts Institute of Technology, drawn June 25th, early in the morning, after standing some 14 hours in the lead pipe, which is about 150 long and has been in use several years. 100,000 part of this water con-

* From the Report of the State Board of Health, 1871.

tained 0·098 part metallic lead, equivalent to 0·057 grain to the gallon.

No. 6. Water from the same pipes as No. 5, after running out enough to clear the pipes. 100,000 parts of this water gave 0·0307 part metallic lead, equivalent to 0·0179 grain to the gallon.

No. 7. Water from private residence, No. 8 Sawyer street, Sept. 20th. The water had been let into the pipes only four days previously, and, at the time the sample was taken, had remained in the pipes for three or four hours. The pipe (lead) is some 50 feet in length. 100,000 parts of this water gave 0·073 part metallic lead, equivalent to 0·0427 grain to the gallon.

No. 8. Water from private residence, Kendall street, Sept. 26th. This water was let into the pipes some four months since, and none had ever been drawn previous to the time. 100,000 parts of this water gave 0·0937 part metallic lead, equivalent to 0·0547 grain to the gallon.

No. 9. Mystic Water from private residence, No. 12 Adams street, Charlestown, 7½ o'clock A. M., Sept. 6th. There are about 50 feet of lead pipe, which have been in use for 2½ or three years. Very little water had been drawn since July 1st. 100,000 parts of the water gave 0·120 part metallic lead, equivalent to 0·0695 grain to the gallon.

No 10. Mystic Water from Kidder's Chemical Works, Charlestown. Drawn 7 A. M., Sept. 6th, after remaining 13 or 14 hours in the pipes. Considerable quantities of water are used, and the pipe, 200 feet in length, has been in use four or five months. 100,000 parts of this water gave 0·120 parts metallic lead, equivalent to 0·0695 grain to the gallon.

Boston, Dec. 26, 1874.

CHINESE LACQUER.

The following is extracted from the *Courier de Saigon*:—

"It was supposed for a long time that the lacquer was a peculiar compound of which the Chinese and Japanese carefully guarded the secret, and the Catholic missionaries, and especially Père Incarville, we are told, were the first to learn that this precious varnish, which gives so much lustre to wood-work of all kinds, was simply a resin of rather reddish color, extracted, by incision, from a tree indigenous to some provinces of China and Japan.

"The same missionary gives an account of the mode of preparing and employing the varnish obtained from this resin. The first operation consists in removing from the juice of the tree all the water, and for this purpose it is exposed to the sun for two or three hours, being stirred all the time with a wooden spatula. Without the evaporation thus caused the varnish would not possess its beautiful transparency. Certain substances are added to produce the varieties of varnish known in Chinese industry; thus, to produce the fine ordinary varnish, pig's gall and Roman vitriol are dissolved in a little water; to produce the fine black Japanese varnish, of which the Chinese remained long ignorant, powdered hartshorn, charcoal, or ivory black is mixed in certain proportions with tea oil, and added to the resinous liquid.

"An able Chinese artist, in executing ornamental work in gold or colors, commences by sketching his design on the varnished wood with a brush and white lead; when satisfied with his outlines, he passes over them a very fine steel point, and then traces all the details. More often, however, the design is first sketched with pencil on paper, and finished with Indian ink. These latter designs are then carefully brushed over by apprentices, with orpiment dissolved in water, and are immediately applied to the varnished wood, the hand being passed over the paper, so that all the parts of the design are transferred to the wood. When the paper has been taken off, all the lines are retouched with orpiment or vermilion in gum-water, which fixes the design firmly on the lacquer, and then with varnish, mixed with a little camphor, which renders it more liquid; and this, when dry, is ready to receive the shell-gold in powder, applied by means of a puff or dabber over the whole of the design; the surface is then lightly wiped or rubbed, when every line of the original design becomes brilliant.

"When it is desired to bring portions of the design into relief, such as the inequality of the trunks of trees, the nerves and veins of plants, etc., the camphor varnish is applied over the gold, and the gold again over that, often many times, until the desired relief is obtained. All the important lines of the design, the eyes, lips, etc., of figures, the folds of drapery, and all the ornamental portions of the work, are touched up carefully with a brush.

"Beautiful as Chinese lacquered work is, that of Japan excels it; and one cause of this is the superior transparency of the Japanese varnish, which is as limpid as the purest water, while that of the Chinese has always a yellow tinge.

"Kang-hi, the famous Emperor, who was a great connoisseur and patron of art, admitted the superiority of the Japanese lacquer work, but he attributed it to the climate, stating that the production of the best varnish required a soft, fresh, humid, and calm atmosphere; that that of China was rarely temperate, almost always hot or cold, and charged with dust and salts, while Japan, being surrounded by the sea, had just the sort of air to dry varnish, without causing it to become wrinkled or discolored. This opinion of the Emperor is borne out by the practice of the lacquerers of the present day; and it is a known fact that the air of China is often loaded with dust, which the rain brings down in the form of mud.

"White lacquer is made by mixing silver-leaf, carefully divided, with the ordinary varnish; red lacquer by the mixture of mineral cinnabar or carthamin flowers; yellow lacquer with the addition of orpiment only; green is produced by a mixture of orpiment and indigo; and violet lacquer by the addition to the varnish of a certain mineral of that color, reduced to an impalpable powder. The older the articles varnished with the above, the more brilliant and beautiful are the colors. Another compound lacquer of which the materials are not given is used by the painters for the richest Chinese ornamental work which is decorated with gold.

"The perfection of Chinese and Japanese lacquer work does not, however, depend solely on the excellence of the varnish, or the careful preparation of the various colors, for the application of the lacquer demands the most elaborate pains. In the first place, the surface of the wood to be lacquered is prepared with the greatest care; when necessary, the joints are filled in with fine tow and then covered with thin strips of silk or paper. The surface is then dressed with an oil obtained from a certain tree which grows on the mountains and highlands of China; when the oil is perfectly dry, the varnish is applied. With two or three coats of the varnish, its transparency is so great

that all the veins and marks of the wood are perfectly distinct; to disguise the wood entirely many more coats have to be laid on, and finally the surface is made as smooth and brilliant as glass.

"It is on such a surface that the gold and silver ornamentation is effected, and the whole, when finished, is preserved by a light coating of the varnish.

"Another kind of lacquer is produced by covering the surface of the wood with a composition made of paper, tow, lime, and some other materials. This is laid in the form of paste, and produces a solid and uniform ground with which the lacquer amalgamates.

"The lacquer and varnish are laid on with flat brushes with excessively fine hairs, at first in all directions, but equally, and afterwards lightly and in one direction, each coat being allowed to dry perfectly before another is laid on. No single coat exceeds the thickness of the thinnest paper, otherwise irregularities would be produced which could not afterwards be corrected.

"The workshops in which lacquered work is produced are closed in the most careful manner, in order to prevent the possibility of dust, the men even taking off all their clothes except a pair of drawers. Contrary to all European practice, the lacquered work is dried in places which are rather damp than otherwise, and the workmen exhibit the greatest ingenuity in keeping the atmosphere therein in perfect condition. When a coat of varnish is sufficiently dry, the slightest irregularities are removed by burnishing with an instrument made of a hard composition of brick, extremely finely powdered, and mixed with a certain oil, pig's blood, lime-water, and a peculiar kind of earth common in China. The last coat of varnish is not, however, touched with the burnisher, which would dim its lustre. Upon the perfection of this last coat all the beauty of the work depends, and the greatest care is taken that no particle of dust shall reach it, and no foreign substance touch it but the hair of the finest sable. It is only under these elaborate conditions that the beautiful lacquer work of China and Japan can be produced."—*The Engineer.*

NOTES ON THE THEORETICAL VIEWS OF THE CONSTITUTION OF BLEACHING POWDER.

BY DR. LUNGE.

The oldest formula proposed for bleaching powder seems to have been Ca O Cl (according to the old notation), but in 1835 Balard (*Annales de Chimie et de Physique* (2) lvii. p. 225) after having studied the properties of sodium hypochlorite, came to the conclusion that the constitution of "chloride of lime" was a similar one, and, doubling the above formula, distributed it as an equivalent of calcium hypochlorite, and an equivalent of calcium chloride: Ca O Cl O + Ca Cl (or $Ca Cl_2 O_2$ + $CaCl_2$, new notation), mixed with an excess of Ca O H O. The celebrated Gay Lussac, in 1842, gave further reasons for this theory (*Annales de Chemie et de Physique* (3) v. p. 273), and it has remained the dominant one up to this day, and is generally to be found in the ordinary chemical text-books. In 1861, Fresenius published (*Liebig's Annalen*, vol. cxviii. p. 217) researches upon this subject, the result of which led him to the formula Ca O Cl O + Ca Cl, 2 Ca O + 4 Aq. But this formula seems quite untenable, despite the high authority of its proposer and the minuteness of his researches, inasmuch as it only allows of a strength of 32 per cent. available chlorine, whilst it is well known that 39 per cent. can be easily obtained. Besides, Bolley has shown that the compound Ca Cl, 2 Ca O is itself decomposable by chlorine into Ca O Cl, and there seems to be no reason why the action of chlorine should stop short of this in the ordinary manufacture of bleaching powder. Less material is the objection raised by Odling (in his *Manual of Chemistry*) that the above formula cannot be correct, because alcohol does not dissolve calcium chloride from bleaching powder, and because the latter does not deliquesce, for both the one and the other fact are disputed by most other observers. Odling's own formula is: $Ca\{^{Cl\,O}_{Cl} + H_2 O$. During the last few years several valuable papers have been published by chemists who combine practical knowledge of the manufacture of bleaching powder with that of scientific chemistry, and they nearly all seem to agree that, whilst the product of the action of water upon bleaching powder, as well as the so-called "bleach liquor," contains a mixture of calcium hypochlorite and calcium chloride, yet in the *dry* bleaching powder the calcium hypochlorite does not seem to exist. I do not here take into account the paper (*Comptes Rendus*, vol. lxxiv. p. 1411) published by Crace Calvert in 1872 (giving the formula Ca O Cl O + 2 Ca Cl), because Kolb has shown his analytical method to be entirely fallacious, and even theoretically Calvert seems to have made a grave omission, since 3 Ca O and 3 Cl (old equivalents) do not exactly give Ca O Cl O + 2 Ca Cl, but leave an O to spare, which is not in any way accounted for.

Kolb (in the *Bulletin de la Société Chimique* for 1868, ix. p. 82) showed that *dry* carbonic acid acts upon *dry* bleaching powder in such a manner that, besides calcium carbonate, only free chlorine, and no hypochlorous acid, is generated; he, therefore, rejected the formula of Balard, and returned to Ca O Cl ($Ca O Cl_2$, new equivalents), his exact formula being 2(CaOClHO) + Ca O H O. In damp air, however, bleaching powder yielded to him hypochlorous acid. Bobierre (*Ibidem*, p. 172), and Scheurer-Kestner (*Ibidem*, p. 159), did not contradict Kolb upon this point, but they showed, in opposition to him, that if the temperature be raised too much, chlorine acts upon calcium hydrate so as partly to set free the water of hydration, and they both show (what is known to all practical men) that if a great excess of chlorine acts upon strong bleaching powder, the *available* chlorine in the product is actually reduced. In 1873 Goepner published a long memoir on bleaching powder (*Dingler's Journal*, vol. ccxxxix. p. 204). He showed that the well-known fact of calcium chloride being always present in bleaching powder over and above that demanded by the formula CaOClO + CaCl, is caused by the presence of calcium carbonate in the lime employed for absorption, either from imperfect burning, or recarbonation of the same, or from carbonates present in the manganese, the action of chlorine upon calcium carbonate being represented by the equation: $Ca O CO_2 + 2 Cl = Cl O + Ca Cl + C O_2$. In his opinion this calcium chloride forms a wall which protects a portion of the calcium hydrate from the action of chlorine, and thus he explains the long-established fact that there is always a quantity of calcium hydrate present in bleaching powder, but he denies any chemical combination of it with Ca O Cl. He strongly objects to considering the latter as composed according to Balard's theory, his principal argument being that on distillation with strong acids it does not yield hypochlorous acid, but only free chlorine. Goepner distinguishes the one from the other by shaking the distillate with mercury, which with Cl gives a white precipitate,

but with Cl O a brown precipitate. The latter Goepner professes never to have obtained, but he is contradicted upon this point by Schorlemmer, who, however, leaves untouched the argument which Goepner shares with Kolb, viz., that CO_2 never evolves from dry bleaching powder anything but Cl. Goepner further maintains that the peculiar smell of bleaching powder is in reality only that of very diluted chlorine, and that it can be exactly imitated by letting a drop of chlorine water fall into a half-gallon bottle full of air.

The newest paper upon this subject (just published) is by Richters and Juncker (*Dingler's Journal*, vol. ccxi. p. 31). Whilst contradicting both Kolb and Goepner on several points, they come to the same conclusion as to the constitution of bleaching powder, viz., that the assumption of the existence of calcium hypochlorite in dry bleaching powder is untenable, and that there must be a ternary compound Ca O Cl (or $Ca O Cl_2$, new notation), about whose internal constitution nothing is as yet known. R. and J. maintain that CO_2 has no perceptible action at all upon *dry* bleaching powder, and that from *damp* bleach it evolves both Cl and Cl O. They also found that according to the mode of manipulation the action of strong acids upon bleach will either yield only Cl, or only Cl O, or both, but the question can be better approached by using phosphoric acid, which does not act upon calcium chloride, and yet evolves from bleach (upon distillation) only chlorine. They reject mercury as a reagent for the distinction between chlorine and hypochlorous acid, as leading too easily to wrong conclusions; instead of this they proceed by titrating 20 c.c. of the distillate with arsenious acid, and another 20 c.c. with silver nitrate, after neutralizing it with ammonia and evaporating to dryness. They give the following equations:—

$$Cl O + As O_3 + HO = As O_5 + H Cl.$$
$$2 Cl + As O_3 + 2 HO = As O_5 + 2 H Cl.$$

The same amount of arsenious acid, therefore, corresponds to one H Cl, and one $Ag O N O_5$ for hypochlorous acid, but to 2 H Cl and two $Ag O N O_5$ for free chlorine, and in fact it is found that the distillate corresponds with the latter assumption only. Another experiment seems to them even more decisive against Balard's theory, viz., that 1 grm. bleaching powder, boiled with a solution of phosphoric acid and precipitated with argentic nitrate, only shows 2·99 per cent. Ca Cl. On the other hand, their experiments again show that a *solution* of bleaching powder behaves like a mixture of calcium hypochlorite and calcium chloride. Last of all, R. and J. controvert Goepner's idea that the constant presence of free calcium hydrate in bleach is attributable to its being protected by calcium chloride, but they seek the explanation of the above in the fact, first established by Graham, that perfectly dry calcium hydrate is not acted upon by chlorine, and they show that it is indifferent whether the calcium hydrate is deprived of its moisture by heat, or by the presence of other bodies having a greater attraction for water, such as calcium chloride, or even the bleaching compound Ca O Cl, whose hygroscopic properties are well known. —*Trans. Newcastle-upon-Tyne Chem. Soc.*

THE MANUFACTURE OF BORACIC ACID IN TUSCANY.

BY P. LE NEVE FOSTER, JUN., C.E.

The production of boracic acid in Tuscany from the hot boiling springs and jets of vapor called *soffioni* is certainly one of the most important branches of chemical industry in Italy. The curious phenomenon of jets of vapor issuing naturally from the ground is met with over an area of comparatively limited extent, situated between Massa Marittima and Volterra. The hill-sides in many of the valleys of the tributaries of the River Cecina are studded with such *soffioni*, and numerous *lagoni*, or ponds of muddy blue water boiling vehemently, have been formed by the natural springs, acted on by these vents of vapor.

Towards the close of the last century (between 1770 and 1780) boracic acid was discovered in the springs of Monte Rotondo and Castelnuovo, by Hœffer, the chemist to the Grand Duke of Tuscany, and by Professor Mascagin, but no steps of any importance for utilizing these springs for making boracic acid appear to have been taken until 1818, when Mr. Francois Lardarel, a Frenchman, established works on a small scale for the collection and extraction of this substance from the waters of the *lagoni* in the neighborhood of Castelnuovo. At first his efforts were unattended with success, and, in a commercial point of view, may be said to have proved a failure, owing to the great expense of obtaining fuel for evaporating the water. At length the brilliant idea struck M. Lardarel of employing the heat of the natural steam jets to evaporate the weak solution from the *lagoni*, and this was the turning point in his fortunes. This method, which was first applied in 1827, had the effect of converting an unprofitable branch of industry into one of the most successful in Italy. At the present time there are no less than seven separate establishments belonging to Count Lardarel, all situated within a few miles of the little town of Castelnuovo, which may be said to be the centre of the boracic acid industry in Italy. These establishments are as follows:—

1. Lardarello, or Lagoni, of Monte Cerboli.
2. Castelnuovo, Val di Cecina.
3. Serrazeano, or the "Lagoni Solforei."
4. Lustignano, or the "Lagoni Rossi."
5. Sasso, or the "Lagoni di Acquavita."
6. Monte Rotondo, or the "Logoni della Pianacce."
7. "Il Lago," where the works of San Federigo, San Eduardo, and La Collacchia are situated.

The works at Lardarello are the most important of all, and it is there that all the products of the other establishments are sent. The processes by which the acid is extracted being precisely the same at each, it will only be necessary to describe in detail those carried out at Lardarello. This little colony, which was founded by the late Count, is situated at a short distance from the village of Monte Cerboli, on the torrent Possera, and shows what might be done in other parts of Italy for improving the social condition of the working classes. There is a neat square, "La Piazza dell' Industria," surrounded by blocks of buildings, which on one side include the offices, church, museum of mineralogy, and schools, and on the other, the model lodging-houses for the workmen, stores, workshops for various tradesmen, such as tailors, shoemakers, etc., and a weaving establishment for giving employment to the wives and daughters of the workmen.

The *lagoni* are situated to the south of this little village, and consist of artificial basins constructed of coarse masonry, large enough to contain several *soffioni*. At the present time most of these *soffioni* are obtained artificially by boring, and are lined with sheet iron tubes from 25 to 30 centimetres (10 to 12 inches) in diameter. These borings are found more manageable,

besides giving out more vapor than those formed naturally. The basins, or *lagoni*, are situated at different levels on the hill-side, and the uppermost is supplied with water conducted by a canal from near the Bagno del Norbo. After remaining in this basin for twenty-four hours, during which time it has been kept in constant agitation by the subterranean vapors, and has become of a slate blue color, the water passes into a canal, and is conducted to another basin at a lower level, where it remains another twenty-four hours, and in consequence takes up an additional quantity of boracic acid.

The water, after passing through a chain of *lagoni*, where it is brought up to a strength of about 0·50 per cent. of boracic acid, is then conducted to a large tank, about 20 metres (66 feet) square and ½ a metre (1 foot 6 inches) deep, covered by a tiled roof supported on brick columns. Here it is allowed to settle, the impurities held in suspension are precipitated to the bottom, and the water leaves the tank in a perfectly clean state.

The next operation is to concentrate this weak solution of acid. This is effected by evaporating it in long lead pans, ingeniously heated with steam from the dry *soffioni*. These pans are about 60 metres (200 feet) in length by 2·50 to 3 metres (8 feet 4 inches to 10 feet) in breadth, arranged usually in three parallel lines under one roof, supported on columns, the sides being open so as not to impede the evaporation. The pans are supported on beams over low steam passages, into which the vapor is conducted by pipes from the *soffioni*. Formerly a masonry arch was built over one of the natural springs, and the steam collected in this manner; but these buildings were liable to be undermined, and attacked by the corroding influence of the vapors, and it is now found far more convenient to connect the pipes to the tube of an artificial boring, to say nothing of making a neater job and the arrangement being more under control. The pans have a number of divisions placed transversely across them, usually from 80 cent. to 1 meter (2 feet 7 inches to 3 feet 4 inches) apart. These divisions are 0·05 metre (2 inches) in height, and the pans are arranged so as to have a slight inclination from the end where the water is admitted towards the other, where there is a large and deep reservoir. The water is allowed to enter in a regulated quantity from the precipitating tank, and following from one division to another, it gradually evaporates, and after having passed over 50 to 60 divisions, it assumes a bright yellow hue, increasing in intensity as it approaches the end, where it runs into the tank or boiler. Every 24 hours this boiler is emptied, and its contents pumped up to the crystallizing house, in which a series of vats about a metre (3 feet 4 inches) in diameter are placed. These vats being filled, the liquor is allowed to remain four days, during which time the boracic acid is deposited in crystals at the bottom and sides to a depth of a few inches, and the liquid that then remains is drawn off by removing a plug at the bottom, and conducted away by a drain to the evaporating house. Fresh liquid is then introduced into the vats, and the same process is repeated until they are completely filled with crystals of boracic acid. As these crystals retain a large amount of water, they are, when removed from the vats, placed in large wicker baskets to drain, and are afterwards taken to the drying-house, where the contents are spread in thin layers on the floor, and stirred constantly with a wooden rake. It is then packed in barrels containing about 600 kilos. each (12 cwt.), and sent to Leghorn, where it is shipped chiefly for England.

The boracic acid manufactured in this manner contains about 13 per cent. of impurities, chiefly sulphate of lime, ammonia, alumina, and magnesia.

At the Lardarello Works there are 12 evaporating sheds, containing 35 evaporators. The average daily production is about 3000 kilos. (3 tons), though some days as much as 4200 kilos. (4 tons) have been made. The Castelnuovo establishment averages 26,700 kilos. (27 tons) per month, and the production of the other works is still less. The total annual production of the whole of the establishments belonging to Count Lardarel is estimated at 3000 tons.

Notwithstanding the extreme simplicity of the whole process, it is a matter of surprise to many who have visited these works, and it is much to be regretted in the interests of science, that Count Lardarel (whose motto is evidently "rest and be thankful," instead of "progress") has not thought fit to employ a chemist at his establishment, and up to the present no progress has been made in this manufacture since the first application of steam by the late Count in 1827, although it is highly probable that, under the management of a scientific man, considerable improvements might be introduced.

M. Durval has an establishment for the manufacture of boracic acid at the Lake of Monto Rotondo, called also "Il Lago Solforei di Vecchiena," which has an area of about 18 acres. The water contains about 0·002 of acid. The produce of these works is sent chiefly to France.

At Travale, an Italian company, called the Società Anomonia Borica Travalese, have an establishment for extracting the boracic acid which is found there, though in a far more diluted state than at the *lagoni* of Count Lardarel, and although the process by which it is extracted does not differ in principle from that previously described, certain very important modifications and improvements have been introduced. These springs, which are called "I Lagoni dello Galleraje," are situated at a short distance from the village of Travale, in the valley of the Sajo, a little stream flowing into the Feccia and Merse tributaries of the Ombrone. Here the boracic acid is associated with sulphate of ammonia, which is extracted from the waters of a series of *lagoni* by evaporating apparatus, heated by the natural vapors of the *soffioni*, but as the sulphate of ammonia is worth only 35 francs per quintal, whilst the boracic acid is worth 50 francs, and the cost of production is almost equal, there is very little profit attendant upon its manufacture. The water of these *lagoni* contains about 500 milligrammes (about 7 grains) per litre (1¾ pint) of sulphate of ammonia. All the *soffioni* at this place have been obtained by boring, and this company are possessed of excellent tools for this purpose, by means of which they are enabled to bore to a diameter of 40 centimetres (16 inches). These borings usually meet water at a depth of from 15 to 20 metres (50 to 70 feet), though in one place a depth of 168 metres (560 feet) was reached before tapping these subterraneous sources of heat, viz.: in a boring called "Il foro Pietro."

Another boring ("Il foro Carlo"), 73 metres (240 feet) deep, furnishes a supply of water holding boracic acid in solution, which rises to the level of the ground, as in an artesian well, its supply being equal to 600,000 litres (132,144 gallons) per 24 hours, of which only one-sixth part is at present utilized. This solution contains only 260 milligrammes (about four grains) per litre (1¾ pint) of boracic acid, which is given off at a tem-

perature of 96° Cent. (205° Fah.). Here there is no basin, as at Lardarello, the water being led away direct by cast-iron pipes from the bore-hole to the precipitating tank, which is 18·50 metres (60 feet) in length, by 13·50 metres (45 feet in width), and 0·50 metre (1 foot 8 inches) in depth. The improvement that has been introduced here consists in heating the water in this tank by pipes, through which the vapor from a dry *soffioni* ("Il foro Filippo") passes, and by this means a certain amount of water is evaporated in the precipitating tank, and thus brings up the degree of concentration of the solution to 400 milligrammes (6 grains) per litre (1¾ pint). The boring that furnishes the steam is 63 metres (210 feet)in depth, and the temperature of the water in the tank is maintained at 94° Cent. (202° Fah.). This solution, which has a specific gravity of 11° of Baumé's areometer, is conducted in the usual manner to the evaporators, which are constructed in a similar manner to those at Lardarello, the water being kept at a temperature of 76° Cent. (169° Fah.), by the steam from "Il foro Filippo," and having traversed the entire length of the pans is received into the boiler at the lower end with a specific gravity of from 12° to 50° Baumé, and is crystallized, dried, and packed in the usual manner. The evaporating shed contains three rows of evaporators, 64 metres (207 feet) in length by 3 metres (10 feet) in width. The production is about 26 kilos. 200 grammes per day (57·64 lbs.).—*Pharm. Journ. and Trans.*

CHEMICAL NOTES FROM FOREIGN AND AMERICAN JOURNALS.

In the preparation of these abstracts the Editors are assisted by the following chemists:—

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Bulletin de la Société Chemique de Paris.

Vol. xxii. No. 3.

On the so-called **colloid matter of tissues** in process of degeneration.—A. Gautier, P. Cazeneuve, and G. Daremberg.—Researches were made upon matter extracted from a large cyst from an ovary. It was found that the insoluble colloid matter passed into the soluble form on being heated with water in a sealed tube at 110°. Mineral matters was separated by dialysis, and from the remaining liquid alcohol precipitated a substance which on being dried and analyzed gave a composition corresponding quite closely to the formula $C_6H_{15}NO_6$. This substance is called by the authors colloidine, and closely resembles in its composition a similar substance analyzed by M. Wurtz.

A **new eudiometer.**—A. Dupré.—A modification of the apparatus of Regnault and of Doyere. As a transcription of the entire article is necessary to render it intelligible, the reader is referred to the original paper.

A **urometer and nitrometer.**—A. Dupré.—The apparatus used is similar to that of MM. Yvon and Magnier de la Source, and is employed for the determination of urea or nitrogenous matter by means of hypobromite of sodium.

On the action of **sulphuric acid upon lead.**—A. A. Wallard.—From experiments the following results are adduced:—

1. An acid below 61° Baumé becomes gradually concentrated till it reaches 205°, at which temperature the acid is at 61° B. Then it attacks the lead, giving sulphurous acid and sulphate of lead.

2. Above 61° B. and below 65·5° B. the acid becomes concentrated by ebullition till it reaches 320°, at which temperature it stands at 65·5° B. and attacks lead, producing sulphurous acid, sulphate of lead, and a little sulphur.

3. Acid at 65·5° B. attacks lead at 250°, giving the same products as in the preceding case.

Nos. 4 and 5.

A new **isomer of saccharose.**—Am. Gautier.—The author passes dry hydrochloric acid gas through an alcoholic solution of dextro-glucose, placed in ice and protected from the light. The alcoholic solution is evaporated in vacuo, and treated with baric carbonate and baric hydrate. Treating again with alcohol, evaporating, and purifying by solution in ether, a product is obtained similar in appearance to dextrine, but which is proved to possess different properties from any known isomere of saccharose.

Prepared as above, this sugar has the composition $C_{12}H_{22}O_{11}$, and corresponds with the formula $2C_6H_{12}O_6 = H_2O + C_{12}H_{22}O_{11}$.

Nos. 6 and 7.

Note upon the **phosphates of the sesquioxides of iron and alumina.**—M. Millot.—A description of the process of manufacture and of the properties of salts of iron and of alumina corresponding to the formulæ $PO_5M_2O_3,n(HO)$, $3PO_5,2M_2O_3,n(HO)$, $2PO_5,M_2O_3,n(HO)$.

Isoterebenthene, from a physical point of view.—J. Riban.—The boiling point, rotary power, density at different temperatures, and indices of refraction are discussed and compared with similar determinations previously made with regard to terebene and terebenthene.

Nos. 8 and 9.

Upon the relations which exist between the **atomic formulæ of organic bodies** and the rotary power of their solutions.—J. A. Le Bel.

No. 10.

On the **solution of hydrated salts.**—H. Debray.—By measuring the tensions of the vapors of salts more or less hydrated, it is possible to determine whether there are successive combinations of the salts with water.

Extraction of iodine from fossil calcic phosphate.—M. Thiercelin.—Iodine is present in proportions varying from three to seven ten-thousandths. A patent apparatus is described by which it is possible to utilize the iodine set free in the manufacture of superphosphate of lime, by causing the gas to be absorbed by a solution of potassic sulphite.

Upon **pyrobenzenic carburets, and upon chrysene.**—M. Berthelot.—A compound may be obtained from benzine, which upon analysis gives the formula $C_{36}H_{12} = (C_{12}H_4)_3$. It is proposed to call this triphenylene, and it is not supposed to be identical with the chrysene of Graebe, formerly obtained from coal tar. Diphenylbenzol may be considered as a hydride of this new body; thus $C_{34}H_{12} + H_2 = C_{34}H_{14}$. It is maintained that these two carburets are produced simultaneously by the action of heat upon benzine, and various properties are adduced in proof of this.

On the preparation of **crystallizable formic acid.**—M. Berthelot.—Perfectly desiccated formiate of lead is placed in a U-tube, one end of which has been drawn down and bent. This tube is placed in an oil-bath and heated not above 130°, while at the same time dry hydrogen sulphide is passed through the tube. The formic acid may be purified by distillation and crystallized in a freezing mixture. It melts at +8·6°, which is a higher temperature than that heretofore obtained.

On **acetate of ammonia.**—M. Berthelot.—The salt commonly sold under this name is an acid salt analogous to bi-acetate of potassa, and frequently contains acetamide. To prepare genuine acetate of ammonia dissolve crystallizable acetic acid in caustic ammonia in a cooled retort, at the same time adding enough water to the mixture so that it shall not crystallize during the process of saturation. Evaporate the solution on a water-bath, in a current of dry ammonia gas, till it solidifies upon cooling. Then place the salt in a capsule under a bell glass in an atmosphere of dry ammonia gas. Caustic lime is also placed under the bell glass. The salt is occasionally stirred and the ammonia gas renewed, and after standing quite a long time, a salt is obtained having no acid reaction, and which analysis shows to correspond to the formula $C_4H_4O_4NH_3$.

Acetylides of copper and of silver.—M. Berthelot.—Different analyses of these compounds being reported, the author reconciles them on the ground that they lose water at ordinary temperatures, hence some have analyzed the anhydrous compounds. The relation between the acetylides dried in the cold, and those dried at an elevated temperature, is of the same kind as that which exists between some metallic oxides and their hydrates.

Preparation and properties of **dioxymaleic acid.**—E. Bourgoin.—If bibromomaleic acid is heated several hours in a closed vessel at 160°, and afterwards nitrate of silver is added, a precipitate is thrown down, which on being acted upon with ammonia leaves a residue of bromide of silver. In the process a new organic acid, called dioxymaleic, is formed by the reaction—

$$C_8H_2Br_2O_8 + 2H_2O_2 = 2HBr + C_8H_4O_{10}.$$

This acid may be easily obtained by heating a mixture of dibromomaleate of silver and water in a closed tube. If the temperature is raised to 150°, bromide of silver is formed, and in the filtrate, neutralized with ammonia, a white precipitate of dioxymaleate of silver is thrown down with nitrate of silver.

The discovery of this acid completes a noteworthy series; for if from each of the acids, succinic, malic, and tartaric, we subtract two equivalents of hydrogen, we have the resulting series, maleic, oxymaleic, and dioxymaleic acids.

On the **isomerism of perbromide of acetylene with the hydride of ethylene tetrabromethyl.**—E. Bourgoin.—Experiments are made to prove that these bodies are isomeric with each other, and their theoretical composition is represented graphically.

No. 11.

The **coagulation of albumen.**—V. Urbain.—An explanation of a previous note. The carbonic acid of the albumen liquid is in a great part combined with the salts that make up the nitrogenous matter, and is not simply dissolved in the liquid.

Facts relative to the history of **cyanacetic acid.**—J. van't Hoff.—Various experiments are cited.

Observations on the **rotary power of camphor** and some other bodies.—J. de Montgolfier.

Upon the symbols employed in the designation of **rotary power.**—J. Riban.—It is proposed to obviate the confusion of symbols in the expression of rotary power by designating the determinations made with the monochromatic sodium flame by the symbols a_d to express absolute deviations, and $[a]_d$ to express rotary powers, calling to mind thus that they are connected with the ray D of Fraunhofer. The observations made with the visible colors would be as heretofore represented by the symbol $[a]_j$.

A correction in reference to glycol.—E. Demole.—In the method of making glycol previously published; *i. e.*, by heating together for 18 hours a mixture of equal molecules of bromide of ethylene and acetate of potassa, in the presence of alcohol in excess, the alcohol employed should be of 91% and not of 80% as stated.

No. 12.

Thermal researches on the **phenomena of solution**; action of water upon nitric acid.—M. Berthelot.—A table is constructed and a graphic curve described from the results of experiments with nitric acid. This curve, in the form of a hyperbola, is analogous to those representing the dilution of hydrated acids and of the alkalies. It shows in a general way that the heat of dilution diminishes very nearly in inverse ratio to the water already united with the acid. From a study of the graphic curve it is evident that several definite hydrates exist. Experiments teach that the curve of hydration of nitric acid is distorted in proportion as the temperature is elevated. Its ordinates increase continually, but never more rapidly than when they correspond to a small value of x, or as the acid is concentrated. At the same time when it loses its minimum and goes above the axis of x, the curve becomes more regular.

On the **definite hydrates** formed by the acids and the alkalies dissolved.—M. Berthelot.—The author claims:—

I. The existence of certain definite hydrates, or rather of certain limits of equilibrium in the combination of water and the substance dissolved.

II. That these hydrates exist in the solutions just as much as if crystalline salts might be isolated.

III. Each solution is formed by a mixture of a part of the free solvent with a part of the body dissolved, combined with the solvent, following the law of definite proportions.

Many definite hydrates of the same body can be considered as existing at the same time in the solution.

The proofs of the theory are:—

1. The unequal tension of anhydrous bodies and of their hydrates when both are volatilized.

2. The chemical reactions which may be reversed by varying the concentration of the solvent, as the action of hydrochloric acid on sulphide of antimony.

3. The inverse reactions which take place when iodhydric acid acts upon sulphur, and when sulphydric acid acts upon iodine, in the presence of water.

4. The precipitation of certain saline solutions, as of chlorides of the alkalies, by concentrated solutions of hydrogen acids.

5. The curves studied in reference to the heat disengaged by the hydration of acids differently concentrated.

Note upon the **synthesis of purpurine.**—Felix de Lalande.—By making nitrate of methyl react upon alizarine, a body similar to alizarine in appearance has been obtained. A body called nitroxyalizarine by Strecker has been also prepared by the process he describes, and appears to be identical with the product named above. As proof, purpurine was treated with fuming nitric acid, and a body obtained having the same properties as the nitroxyalizarine of Strecker; hence the latter was nitrate of purpurine.

Two stages may be distinguished in the action of nitric acid upon purpurine: 1. The transformation of alizarine into purpurine. 2. The substitution of nitryl in the purpurine formed.

Upon the distribution of the bands in the **primary spectra.**—G. Salet.—The theory of the existence of the primary spectra is illustrated by a figure, and a discussion follows. E. H. S. B.

The Chemical News.

No. 796.

On the **manufacture of caustic soda.**—John Morrison.—The first of a series of papers giving a detailed account of the apparatus and processes used by the author in the works at Newcastle-on-Tyne.

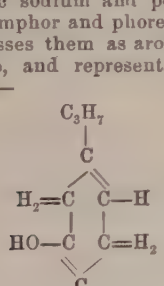
On the value of the so-called **chameleon barometer,** as a hygrometer.—A. Percy Smith.—The author finds that a piece of bibulous paper soaked in cobaltous chloride is blue when dry, and red when moist, and is very sensitive to slight changes in the quantity of moisture in the atmosphere.

No. 797.

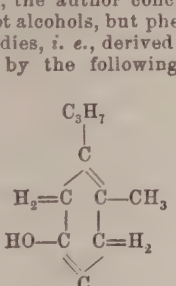
Second note on **sulphovinic acid.**—T. L. Phipson.—The author concludes that the difficulty of obtaining the pure acid, and the tendency of its salts to decompose, will forever preclude their use in pharmacy.

No. 798.

On the nature and constitution of **camphor and phorene.**—C. J. Blanshard.—From their reactions with metallic sodium and potassium, the author concludes that camphor and phorene are not alcohols, but phenols. He classes them as aromatic bodies, *i. e.*, derived from benzine, and represents them by the following formulæ:—



Phorene.



Camphor.

No. 799.

On some reactions of **metallic sodium in chloroform.**—S. Kern.—In the first experiment, the author obtained the following reaction:—

$$CHCl_3+3Na+H_2O=2NaCl+NaHO+HCl+C+H.$$

In the second he obtained a sodium salt of formic acid ($NaCHO_2$), which gave with sulphuric acid free formic acid ($HCHO_2$).

No. 801.

On **Estremadura phosphorite.**—B. C. Niederstadt.—The amount of phosphoric acid is 28 per cent., which is 6 per cent. less than the Baker, Curaçoa, and Bolivia guano.

No. 802.

On some properties of **nitro-glycerine.**—S. Kern.—The author found that, at the following temperatures, nitro-glycerine underwent the following modifications:—

187°—ebullition; separation of orange vapors.
220°—strong explosion.
262°—the strongest explosion.
294°—very feeble explosion, accompanied by a yellowish flame.

He therefore concludes that the explosive properties diminish at high temperatures. E. H. W.

Journal de Pharmacie et de Chimie.

January, 1875.

Titration of potassic iodide, by means of standard solutions.—13·55 grammes of mercuric chloride are dissolved in one litre of water, with the assistance of 8 to 10 grammes of NaCl or KCl. 33·2 grammes of the iodide to be tested are dissolved in 1 litre of water (or 3·32 grammes in 100 c. c.). Of this last solution 10 c. c. are taken. The mercury solution is added drop by drop from a burette, the iodide solution being all the time briskly agitated until a permanent red precipitate forms. The process cannot be reversed with accuracy, *i. e.*, the iodide solution added to the mercury solution.

Observations on some of the physical **properties of quinine.**—J. Regnauld.

100 grammes of—			Contains grammes.	Coefficient of solubility.
Water solution, saturated at		15°,	0·0494	$\frac{1}{2024}$
"	"	100°,	0·1314	$\frac{1}{760}$
Absolute alcohol solution	"	15°,	46·866	$\frac{1}{1.133}$
Chloroform	"	15°,	34·177	$\frac{1}{1.926}$
Ether	"	15°,	4·2314	$\frac{1}{22.632}$

The chlorine and ammonia test for quinine gives a decided reaction in a solution containing 1 part of quinine in 2000. The gallotannic acid is perceptible with $\frac{1}{20000}$ of quinine The fluorescence of a water solution of quinine of $\frac{1}{2000}$ is almost invisible; by the use of a lens it may, however, be seen when this solution is only one-tenth as strong. The addition of an excess of sulphuric acid increases the fluorescence so much that it may be seen when the solution is diluted to the $\frac{1}{300000}$; hydrochloric acid interferes with this fluorescence.

Action of **heat on ordinary aldehyde.**—M. Berthelot.—A mixture of 5 volumes hydrogen with 2 volumes of aldehyde vapor was heated to a red heat for half an hour. One-sixth of the aldehyde remained, another sixth had disappeared. The remainder appeared to have decomposed, according to the following formula:—

$$C_4H_4O_2=C_2H_2,C_2O_2H_2=C_2O_2+C_2H_4.$$

Toxicological **examination for potassic cyanide** in the presence of non-poisonous double cyanides.—E. Jacquemin.—A cyanide boiled with sodic hyposulphite yields a sulphocyanide, which may be detected by a ferric salt, *e. g.*—

$$KCN+Na_2S_2O_3=KCNS+Na_2SO_3.$$

Heating to 50° or 60°, and testing with picric acid for the isopurpuric acid coloration, is also recommended.

To obtain the hydrocyanic acid from potassic cyanide, treatment with carbonic acid is stated to be sufficient.

New facts on the **mutability of microscopic germs.** Passive role of organisms classed as ferments.—J. Duval.—This interesting paper is illustrated with plates, showing the appearance of the microscopic organisms in states of change. The headings of the subdivisions of the paper are as follows:—

First proof.—Transformation of the alcoholic ferment

into the lactic ferment in presence of a neutral solution of sugar. Indirect application of this process to the preparation of pure calcic lactate.

Second proof.—Transformation of an alcoholic ferment into a benzoic ferment.

Third proof.—Transformation of an alcoholic ferment into an undetermined ureic ferment.

On the **coloration of candies.**—M. Chevallier.—The colors allowed to be used by the Council of Public Hygiene and Health of the Seine Department are as follows:—

Blues.—Indigo and Prussian blue.

Reds.—Cochineal, carmine, carmine lake, Brazilwood lake, and archil.

Yellows.—Saffron, Avignon berries, Persian berries, quercitron, turmeric, fustic, and the lakes from these substances.

Greens.—Mixtures of the above-mentioned blues and yellows.

Violet.—India wood and Prussian blue.

Purple.—Prussian blue and carmine.

The papers to be used for wrappers are to be sized paper, and paper colored with zinc oxide and sizing. For colored papers the same colors as are used to color the bonbons are admissible. The colorations for liqueurs have also been specified. For Curaçao, logwood, for absinthe, soluble indigo blue and saffron, for liqueurs, soluble indigo blue.

Mineral colors, except Prussian blue and ultramarine, are proscribed. The colors especially forbidden are copper oxides, blue ash, lead oxides, as massicot or minium, vermilion, chrome yellow, or lead chromate, Schweinfurt and Scheele's greens, lead white, and silver white.

Aniline colors are interdicted, because in the course of manufacture all the mercury or arsenic salts used in their preparation are not always removed.

Moreover, no new color is to be used before it has been submitted to the council, and its use has been authorized.

On **koumiss.**—J. Biel.—The mode of preparing this article at the establishment of Dr. Ebermann, near St. Petersburg, is described. The constitution of the milk is given as follows:—

	In 1000 parts.
Milk sugar	52 to 57·28
Fat	11·08 to 15·62
Caseine	13·09 to 18·23
Lacto-albumen	2·18 to 4·21
Lacto-protein	4·88 to 6·13
Soluble salts, about	0·5
Insoluble "	2·5
Fixed (solids)	94 to 97

The composition of the koumiss of different ages is also given, including the amount of carbonic acid, alcohol, milk sugar, etc.

Crystalline **combination of coniine with iodine.**—R. Bauer.—This was formed by adding an alcoholic solution of iodine, drop by drop, to a solution of coniine in alcohol. Formula $3(C_{16}H_{15}N)3HI.I_3$.

March.

On the limited **oxidation of hydrocarbons.**—M. Berthelot.—The theory of the migration of atoms is characterized as fictitious and more a proof of the incorrectness of the theory than actual phenomena.

On bromated **acetylene perbromide.**—E. Bourgoin.—Bromine will act upon acetylene readily to form this compound. By causing bromine to act upon acetylene perbromide at the temperature of 165° for two days, the same compound, C_4HBr_5 or C_4HBr_3,Br_2, was obtained.

Researches on **albuminoid substances.**—P. Schutzenberger.—Coagulated albumen dissolved in caustic baryta and boiled for some time yielded ammonia and carbonic acid in the same relative proportions as if they had been obtained from urea. Oxalic, sulphurous, and acetic acids were also obtained. Besides these tyrosine, amido acids of the fatty series, and amido acids containing more oxygen and less hydrogen, were formed. The formula for albumen best representing the results of analyses is given as $C_{72}H_{112}N_{18}O_{22}S$. The view that albumen can be considered as a union of leucine and its homologues is, it is claimed, incorrect.

Note on the **determination of glucose in urine** when it exists in very small amount.—M. Strohl.—The reagent recommended is Hager's, made as follows:—

34·65 grms. $CuSO_4$ in 200 c. c. water.

150· grms. neutral potassic tartrate in 500 c. c. caustic soda of sp. gr. 1·14.

100 grms. pure glycerine.

Mix and bring up to 1000 c. c.

The determination should be quantitative always, and in some cases, where the amounts of sugar are too small to give a decided reaction, it is recommended to add to the urine a solution containing a known amount of grape sugar, and then to proceed with the titration, deduction being made for the known amount of glucose added.

The author remarks that the presence of urea appears to prevent, to some extent, the reaction of the glucose on the copper solution, and proposes to investigate the point.

On some **reactions of nitrogenous substances in the organism.**—R. Engel.—The object of this investigation was to discover whether the different groups of compound ammonias acted with reagents in a similar manner to ammonia itself.

The test with phenol and sodium hypochlorite, that with the Nessler reagent and Jacquemin's reaction with ferric chloride and pyrogallol.

1. Phenol and hypochlorite. Glycocol, leucine, and taurine gave blue.

Xanthine, hypoxanthine, urea, and alloxan gave a bluish-green; creatine, creatinine, and tyrosene gave a scarcely perceptible green tinge.

2. Pyrogalloferric chloride gave blue only with creatinine.

3. Nessler's reagent not precipitated by glycocol, leucine, taurine, tyrosine, or urea.

Xanthine, hypoxanthine, uric acid, and alloxan were precipitated canary-yellow.

Creatinine gave a canary-yellow, which rapidly turned black from the reduction of the mercurial solution.

Creatine acts similarly, but the change of color is slower.

On the **state of cantharidine** in the vesicating insects.—M. Beguin.—From experiments it is concluded that the cantharidine does not exist in the insects as cantharidate. Acetic ether is recommended as the best for extracting the cantharidine.

On dextrine.—M. Bondouneau.—Commercial samples of starch were always found to be slightly acid. The results of investigations showed—1st. Dextrine at a high temperature becomes converted into glucose in presence of an inert gas saturated with moisture. 2d. The amount of glucose formed is the greater, the more acid the starch employed, the isomeric transformation being also more prompt.

On an **apparatus for continuous preparation of chlorine** in the cold.—M. Mermet.—Deville's apparatus with two bottles is employed. The gas is prepared from commercial chloride of lime which has been previously rolled into balls that the action may not be too rapid. HCl is the acid used.

On a **new reaction of berberine.**—M. Klunge.—On acidifying strongly with hydrochloric or sulphuric acid a solution containing berberine and then adding chlorine water, a bright red zone forms between the two liquids before they mix, which on shaking spreads through the fluid. Sensitive for one part in 250,000.

Determination of arsenious and antimonious acid in a mixture.—M. Schlagdenhauffen.—A weighed amount is dissolved in Rochelle salts together with an alkaline carbonate. Some indigo is added, and a titred solution of sodic hypochlorite is run in until the indigo is decolorized. This decolorization is not effected until the arsenious acid is converted into arsenic acid, and the antimonious into antimonic acid. By calculation the relative proportions of the two are then found.

Observations on the **presence of lead in the nervous system,** and examination for this metal in cases of poisoning.—Dr. Roucher.—The carbon from the destruction of organic substances by heat or the action of nitric or sulphuric acid retains the lead which it does not yield to nitric acid if but little of the metal is present. Moreover, a solution of lead gives no reaction with H_2S if the solution is acid and but little lead is present. Complete incineration with proper precautions is recommended.

On the **presence of copper in the organism.**—MM. Bergeron and L'Hote.—Different organs from fourteen different corpses were taken and analyzed in a room from which every article containing copper in any form was excluded. Copper was found in every case though in exceedingly small amounts. The coloration with ammonia and the ferrocyanide reactions were chiefly relied upon. E. W.

Revue Hebdomadaire de Chimie.

No. 1.

Bleaching fatty oils.—H. Dieterich.—The oils are first agitated with a weak solution of potassic permanganate, after which hydrochloric acid is added, and they are again briskly agitated and then allowed to settle.

No. 2.

On the beneficial action of hydrocarbons, sulphides, potassic salts, phosphates, etc., used **against the phylloxera.**—C. Mene.—The preference is given to the hydrocarbons from coal tar.

No. 4.

Processes for **prevention of incrustations in boilers.**—On the Orleans railway at Aigrefeuille, the water contains 0·287 grms. per litre of calcic carbonate. The method here pursued is addition of 35 to 38 kilos. of slaked lime to 100 cbm. of water, settling, and filtering. The cost is 4 centimes per cubic metre of water, but this process cannot be applied economically to waters containing less than 0·250 grms. $CaCO_3$ per litre. The Orleans company also uses in its boilers, a mixture of sodic carbonate, tincture of archil and of logwood.

No. 5.

Spectrum analyses of colored liquids.—M. Steine.—In examining the absorption spectrum of a colored liquid, whether the liquid is placed in front of the prism, or between the prism and the eye-piece, or between the eye and the eye-piece, or between the eye and an image of the spectrum thrown on a screen, the results are the same. This shows that the luminous rays from the solution do not pass through the prism, a different state of affairs from the light obtained from an incandescent gas.

Rectification of alcohols.—Report of the commission of the Amiens Society on the improvement of M. LeComte de Beaurepaire.—This consists of heating the phlegms to a point just short of the boiling point of alcohol, and passing a current of some inert gas through them. The ethers more volatile than alcohol are thus more readily removed, and may be separated from the alcohol, which in turn comes over more free from the ethers heavier than itself which impair its quality, when the distillation is effected in the ordinary way.

No. 6.

Researches on the **preservation of wood by means of copper salts.**—M. Rottier.—Cupric acetate and indigo, though good, are too expensive. Heating wood after impregnation with copper sulphates does not give reliable results. Cachon can only be used under certain circumstances. Ammoniacal copper salts are, however, susceptible of very general application, and when applied have more permanent effects than those of other copper salts.

No. 8.

Note on **compressed seaweeds.**—M. Bonaterre.—The fucoids thrown up on the sea-shore contain much that is serviceable for fertilizing purposes. Formerly they were partially burned in order to reduce their bulk. M. Bonaterre proposes, however, to compress them into cakes, and thus avoid the principal objection to their use, *i. e.*, their bulk when transportation is necessary. An analysis of the seaweeds thus compressed gave the following results :—

Water	17·100	organic and volatile matter 77·393.
Nitrogen	1·415	
Organic matter	58·878	
Clay, alumina, silica	0·210	fixed—ash 22·607.
Potassa and soda	6·980	
Phosphoric acid	0·180	
Sulphuric acid	6·170	
Hydrochloric acid	4·800	
Lime and magnesia	3·207	
Loss	0·060	
	100·00	

E. W.

Bulletin de la Société Industrielle de Rouen.

September, 1874.

Note on the **discoloration of aniline black by the peroxide of manganese.**—G. Witz.—Having ascertained that complete destruction of aniline black is effected by the alternate use of potassium permanganate and oxalic acid, an effort was made to separate the oxidizing reaction into two phases. In one, the permanganate forms on the black an adherent brown deposit of oxide of manganese; the excess of the permanganate not decomposed is removed by washing. And, in the second part of the reaction, the oxalic acid acts simultaneously on the two bodies, in a manner that they are rendered soluble and disappear from the tissue without altering these very much. With a solution of potassium permanganate and sulphuric acid, and a small quantity of glycerine, a prompt reduction of the permanganate is effected with a bistre deposit perfectly fixed on the cotton. Oxalic acid effected the discoloration of the black, while the solution became sensibly pinkish. The permanganate may be replaced by the bistre product and a salt of manganese and an alkaline solution. When the bistre of peroxide of manganese, at different degrees of strength, recovers the impressions of aniline black, a more energetic acid should be used. In contrast with sulphuric acid, bistre destroys ordinary aniline blacks in three or four minutes. Oxalic acid destroys the bistre without corroding the black.

On the preparation of **neutral and pure chlorhydrate of aniline and nitrate of aniline.**—G. Witz.

—With crystallized oxalic acid, which had been carefully purified, not containing an excess of moisture, without efflorescence, a solution was obtained called normal at the temperature of 17·5° C., and which served as the standard of caustic soda freshly prepared, at the same temperature of the oxalic acid solution.

With these normal liquors, an equivalent in grammes contained in the volume at 17·5° was determined previously on the pure acids destined to neutralize the aniline. The volume of hydrochloric acid = 96·8 c. c., and for nitric acid = 86·0 c. c.

The solution of hydrochloric acid indicated 20°·35 B. at 15°·4—or 1164.6 gr. for the weight of 1 litre.

The solution of nitric acid indicated 37°·05 B. at 14°·4—or 1346·4 gr. for the weight of 1 litre.

Chlorhydrate of aniline: 500 c. c. pure aniline, 500 c. c. distilled water, 530 c. c. pure hydrochloric acid, being united, immediately a limpid solution is produced, the thermometer rising from 15° to 63°.

The liquid tested with methylaniline violet becomes blue and seems neutral. One drop of diluted hydrochloric acid, added to 10 c. c. of the liquid, gives a green; one drop of hydrochloric acid with 50 c. c. of the solution, blue is produced; with 60 c. c. of the solution, blue slightly purple; with 70 or 80 c. c. of the solution, the same; finally, with 100 c. c. the difference of tint is still marked with the solution which gives the *violet-blue*.

The addition of one drop being sensible on 100 c. c., which corresponds to 1 c. c. on 2000 c. c., containing about 680 c. c. of hydrochloric acid and 650 c. c. of aniline, it is readily seen how 1 part of hydrochloric at 20° B. or 1 part of aniline in excess of a neutral solution containing at least 650 parts of aniline in a state of chlorhydrate, would be easily recognized, and that in operating on less than a cubic centimetre of the liquid.

The liquid is adopted as a neutral solution of the chlorhydrate of aniline.

Nitrate of aniline: 500 c. c. pure aniline, 530 c. c. distilled water, 470 c. c. pure nitric acid, being united, the temperature rises from 15° to 62°, falling after a few seconds. The solution is slightly brown and limpid.

Crystallization commences at the surface at about 55°. To avoid it, distilled water is added in successive portions of 500 c. c. until 4500 c. c. are formed in all.

The reaction obtained is violet-blue, indicating the neutral point.

Then, on

10 c. c. one drop of nitric acid produces green.

50 c. c. one drop of nitric acid produces blue.

75 c. c. one drop of nitric acid produces blue slightly purple.

100 c. c. one drop of nitric acid produces blue slightly purple.

125 c. c. one drop of nitric acid gives a difference still marked with the primitive violet-blue.

The presence of one part of nitric acid at 37° B., or one part of aniline, will be recognized in a solution containing 430 parts of aniline in the form of nitrate, even in operating on less than a cubic centimetre.

The quantity of free aniline which acts on 1 c. c. of that degree of concentration, is about a *quarter of a milligramme*. It is said that pure aniline may contain $\frac{1}{64}$ of its weight of water, though that has not been proved exactly as yet. J. C.

Journal für Gasbeleuchtung.

No. 3, 1875.

Hill's improved process for purifying gas and gas liquors.—This process depends upon the principle that, when a mixture of ammonia water, ammonic carbonate, and ammonic sulphide are warmed, a large proportion of the hydrosulphuric and carbonic acids resulting from the decomposition of their ammonia salts escapes, together with some ammonia, and further, that, when gas containing sulphur compounds and carbonic acid is brought in contact with ammonia, the gas is deprived of most of its sulphur and carbonic acid. The gas liquors are, therefore, first warmed, and then the gas is brought in contact with it, the effect being to remove much of the sulphur from the gas. E. W.

Zeitschrift für Zuckerindustrie.

Vol. III. Nos. 11 and 12.

Experiment in the large way to determine yield.—J. Otokar Cerveny.—403,554 kilos of raw sugar were worked up into sugar fit for market. The raw sugar contained 92·64% cane sugar.

From this was obtained—

White goods	79·54%
Farina	4·32%
Syrup	10·13%
Percentage of raw sugar rendered marketable	93·99%
Loss in manipulation	6·01%
	100·00%

The amount of black used was 142·6% of the raw sugar.

The theoretical yield exceeded the actual yield by 3·66%.

The ways in which this was lost are given, with analyses of the liquors which were allowed to run to waste as being too dilute to treat economically. E. W.

La Sucrerie Indigene.

Vol. IX. No. 11.

Method of **analyzing defecation scums.**—E. Perrot.—The most rapid and accurate method consists in weighing out 100 grms., shaking it up with 380 c. c. of distilled water, adding 20 c. c. of cold saturated ammonic carbonate, breaking up all lumps with a glass rod, allowing to stand some time, filtering off 200 c. c. (representing 50 grms.), inverting by boiling 20 minutes with sulphuric acid, diluting to 400 c. c., and testing by Violette's cuprosodic solution for percentage of sugar. Riffard's method is said to be too complicated, and error is more likely to creep into his mode of working.

No. 14.

Extraction of sugar from scums.—H. Corbin's process.—The principal point in this invention consists in the use of ingeniously constructed filters through which the scums from the settling tanks are passed. The liquors run off quite clear, and may be used as required for dissolving the raw sugar, or such purposes for which pure water is ordinarily employed. It is claimed that the press cakes ordinarily contain about 4 to 4·5 per cent. of sugar, while by the use of this process the amount may be reduced to 0·07 and 0·08 per cent.

No. 15.

Amelioration of the sugar beet. The Coignet fertilizer.—Letter of M. Coignet on the subject.—Fertilizer A, containing—

Nitrogen of torrefied animal matters	6 to 7%
Torrefied degelatinized basic phosphate	30%
Torrefied (animal) organic substances	50%

—was used in the proportion of 600 kilos per hectare. The yield with Silesian beet was 6350 kilos sugar per hectare; the selected beets was 7700 kilos sugar per hectare. The percentage of sugar in the beets was about 12, never less than 11·44 per cent.

Some mixtures of these torrefied animal matters with superphosphates, etc., are mentioned as having given very good results.

Purchase of beets by specific gravity.—S. Cambier.—Making use of the well-known fact that the saccharine richness of the beet is closely proportional to the specific gravity, it is proposed to have three solutions of salt of different strengths. In the heaviest solution if a fair sample sinks, the beets are to be reckoned as first quality; if it sinks in the second but floats in the first, they are to be rated as second quality; and so on. Those beets which float on the third or weakest solution are to be rejected as not marketable.

No. 16.

Amelioration of the sugar beet. Account of experiments made with different fertilizers at Pas-de-Calais.—The composition of the fertilizers used, the distance between the beets, etc., and the yield of beets and percentage of sugar in them, are given in tabular form, with comments and conclusions. E. W.

Polytechniches Notizblatt.

No. 1, 1875.

A few new bleaching processes.—A. Brackebusch.—Four new methods are briefly described. 1. Bleaching by means of stannic oxide dissolved in potassic or sodic hydrate. This is used for both linen and cotton fabrics. 2. The fabrics, which may be silk or wollen, are placed for an hour in a solution of one part common salt and one part oxalic acid in 50 parts water. 3. Equal parts of sodic permanganate and magnesic sulphate are dissolved in lukewarm water, and the goods, from which the grease has already been removed, are immersed in this bath until brown. They are then placed in dilute sulphuric acid (1 part acid to 25 of water) until the brown color has disappeared, then rinsed and put through a soap bath to which a little ammonia has been added. 4. Ramsay's bleaching fluid, which is prepared by pouring water upon equal parts of chloride of lime and magnesic sulphate. The free caustic lime, which would be injurious, is precipitated as sulphate, and chloride of magnesia is produced, which has the same bleaching action as chloride of lime.

New dyestuffs.—E. Crossant and L. Bretonnière.—The production of dyes from wood, horn, starch, moss, cotton, paper, aloes, etc., by dehydrogenation by means of sulphur at high temperature is described. Samples may be obtained of Wirth & Co., Frankfort am Main.

On the **reaction of selenium and tellurium with sulphuric acid.**—Prof. Dr. Hilger.—When tellurium is dissolved in concentrated sulphuric acid by the use of but little heat, a red solution is obtained, from which water precipitates black tellurium. If the solution of tellurium in concentrated acid is boiled a longer time, sulphurous acid is copiously liberated, and there is produced tellurous acid, which on concentrating crystallizes out.

Selenium reacts in the very same manner. The solution, if not too concentrated, may be boiled a long time without change, when suddenly a violent evolution of sulphurous acid begins and selenous acid goes into solution.

In this respect both elements coincide with sulphur.

No. 2.

On the rapid conversion of large quantities of **caustic soda into carbonate.**—Carl Mann.—The caustic soda is a waste product in the manufacture of uranium yellow at Joachimsthal, and is converted into the carbonate by allowing it to trickle down through a barrel of quartz, where it meets a strong blast of pure carbonic acid gas.

On the **use of the residue from roasting pyrites for making iron.**—P. W. Hofmann.—The residues are leached with a solution of common salt, which is thus converted into sodic sulphate, and the mother-liquor is used for preparing zinc chloride.

Potassic permanganate as reagent for hyposulphite of soda in photography.—Fritz Haugk.—The author prepares his test solution by dissolving five decigrammes sodic carbonate, *C. P.*, and a crystal of permanganate as large as a pin's head in 120 c. c. distilled water. If a precipitate falls it must not be filtered out.

On the **durability of external wall finishing.**—Portland cement is recommended as the best facing for brick walls. E. J. H.

RECENT CHEMICAL PATENTS.

March 16, 1875.

160,786.—Manufacture of Lampblack.—Peter Neff, Gambier, O.

March 23d.

161,029.—Lamp-wicks.—Halvor Halvorson, Cambridge, Mass. The wick is subjected to the action of acid or gas, or oxidized by chemical action.

161,005.—Artificial Marble and Processes of Moulding the same.—William Burnet, Chicago, Ill.

161,072.—Processes for Preserving Food.—David Snedeker, Jersey City, N. J. Treats the substance which has been impregnated with sulphurous acid with fumes of burning sugar.

161,073.—Processes and Apparatus for the Manufacture of Illuminating Gas.—Wm. H. St. John, New York, N. Y.

161,100.—Composition Pavements.—David G. Couger, New York, N. Y.

161,118.—Lamp-wicks.—Halvor Halvorson, Cambridge, Mass. To make the wick a better conductor and more easily trimmed. A fibrous lamp-wick, oxidized by means of permanganate of potash.

161,139.—Compounds for Scouring White Goods.—Moritz Mayer.—New York, N. Y.

161,148.—Bronze Liquids.—R. C. Oehmler, Alleghany, Pa.

161,216.—Apparatus for Charging a Stream of Water with Carbonic-acid Gas.—Humphrey B. Dunham, Newark, N. J.

March 30th.

161,320.—Manufacture of Iron.—J. F. Bennett, Pittsburg, Pa.

161,377.—Apparatus for the Manufacture of Coke and Illuminating Gas.—John T. B. Bennett, Birmingham, Eng.

161,388.—Apparatus for Extinguishing Fires.—Jos. H. Connelly, New Brighton, Pa.

161,398.—Manufacture of Steel.—Jean Eyqueur, Paris, France. Heats iron with a mixture of peat with an ammoniacal salt, preferably sal-ammoniac.

161,454.—Air and Gas Engines.—John Taggert, Boston, Mass. Hydrogen gas and air automatically supplied are ignited within the explosive cylinders.

161,504.—Chemical Fire Extinguishers.—Adam Gray, Cincinnati, Ohio.

161,527.—Apparatus for Bleaching Cane-juice.—John M. Lescale, Paincourtville, La. Spiral revolving wings elevate the sulphurous-acid gas, and spray the falling juice; lime-water is used in the juice before this treatment.

April 6th.

161,591.—Calcimine.—Melvin B. Church, Grand Rapids, Mich.

161,666.—Laboratory Gas-burners.—C. D. Cheney, Canandaigua, N. Y.

161,672.—Compounds for Decolorizing Petroleum, Henry Dubbs, Franklin, Pa.

161,728.—Carbonic-acid Gas Generators.—Otto Zwietusch, Milwaukie, Wis.

161,778.—Compositions for Filling the Fibres of Paper.—George H. Goodwin, Boston, and George W. Seaverns, Lawrence, Mass. A filling for the fibres of paper, consisting of calcic carbonate treated with from 3 to 20 per cent. of sulphuric acid.

April 13th.

161,944.—Composition for Preserving Food.—W. C. Donn, Washington, D. C. The composition of boracic acid and alum.

162,043.—Bleaching Jute for Paper-pulp.—George W. Dubuisson, Tom's River, N. J. Submits jute to the action of salts of potash, under low steam pressure, from eight to twelve hours.

6,378.—Refining Sugars.—F. O. Matthiessen, New York, N. Y.

April 20th.

162,140.—Processes for Tanning Hides.—Geo. A. Bartenbach and Charles Richter, Detroit, Mich. Tanning solution: Alum, salt, sulphuric acid, wheat-bran, sulphur, terra-japonica, and mucilage. Dubbing compound: Fish-oil, tallow, linseed-oil, and soda.

162,212.—Soda-water Generator.—James Anderson, Alleghany, Pa.

162,378.—Processes for Manufacturing Lubricating Oils.—Thomas J. Gordon and Delos H. Bumpus, Rouseville, Pa. Decolorizes and

refines crude petroleum by passing it through anhydrous pulverized clay.

162,394.—Processes of reducing Asphaltum to a Liquid.—Archibald K. Lee, Galveston, Texas.

BOOKS RECEIVED.

Analysis of Rocky Mountain Coal. By J. Blodget Britton and C M. Cresson. Pamphlet, 8vo. 3 pp.

Cerebro-Spinal Meningitis.—Report to the State Board of Health of Michigan. By Henry B. Baker, M.D. Pamphlet, 8vo. 193 pp. Lansing, Mich., 1875.

Iron and Steel. By Adolph Schmidt, Ph.D. Pamphlet, 8vo. 12 pp. St. Louis, Mo., 1875.

Spectroscopic Examination of Gases from Meteoric Iron. By Arthur W. Wright. Pamphlet, 8vo. 8 pp.

Annual Report of the Chief Engineer of the Water Department of Philadelphia for the year 1874. Pamphlet, 8vo. 126 pp. and plates. Philadelphia, Pa., 1875.

The Present Status of Electricity in Medicine. By Wm. F. Hutchinson, A.M., M.D. Pamphlet, 8vo 29 pp. Providence, R. I., 1875.

Notes on Explosives, by Walter N. Hill, S.B. Pamphlet, 8vo. 60 pp. and plates. Newport, R. I., 1875.

Second Annual Report of the Board of Water Commissioners of the City of Yonkers to the Common Council. Pamphlet, 8vo. 73 pp. New York, 1875.

The Science of Gems, Jewels, Coins, and Medals, ancient and modern; new edition, revised and corrected. By Archibald Billings. Royal 8vo., cloth. London, 1875.

Burness (Alexander G.) and Mavor (F. J.). The Specific Action of Drugs on the Healthy System: An index to their Therapeutic Value as deduced from Experiments on Men and Animals. 8vo. pp. 184.

Church (Arthur Herbert). The Laboratory Guide. A Manual of Practical Chemistry, for Colleges and Schools. Specially arranged for Agricultural Students. 3d edition, enlarged and revised. Post 8vo. pp. 234.

A Practical Handbook of Dyeing and Calico Printing. By William Crookes, F.R.S., with 11 page plates, 47 specimens of dyed and printed fabrics, and 38 wood-cuts. Royal 8vo., cloth. London, 1874.

Greenwood (William Henry). A Manual of Metallurgy. Vol. I. Fuel, Iron, Steel, Tin, Antimony, Arsenic. Bismuth, and Platinum. Illustrated by 59 engravings. Advanced Science Series.

Guy (William A.). Public Health; A Popular Introduction to Sanitary Science. Part I. A History of the Prevalent and Fatal Diseases of the English Population, from the Earliest Times to the Close of the War of the French Revolution, in 1815. Post 8vo. pp. 342.

——— Public Health: A Popular Introduction to Sanitary Science. Part II. War in its Sanitary Aspects. 12mo. pp. 134.

Short Lectures on Sanitary Subjects. By Richard J. Halton. 8vo., cloth. London, 1874.

The Quantitative Estimation of Ammonia and Sulphur in Coal Gas. By F. W. Hartley. 12mo., paper. London.

Henry (J. T.). The early and later History of Petroleum; with Authentic Facts in regard to its Development in Western Pennsylvania. 8vo. pp. 607. Philadelphia, 1873.

Jordan (James B.). Elementary Crystallography. With which is given a Series of Notes for the Construction of Models, illustrative of the Simple Crystalline Forms. 12mo., sd., pp. 48.

Michael (W. H.), Corfield (W. H.), and Wanklyn (J. A.). A Manual of Public Health, for Use of Local Authorities, Medical Officers of Health, and others. Edited by Ernest Hart. Post 8vo. pp. 370.

Manufacturing Arts in Ancient Times. By James Napier, F.R.S.E. 12mo. cloth. London, 1874.

North (Oliver). The Practical Assayer. Containing Easy Methods for the Assay of the Principal Metals and Alloys. Principally designed for Explorers and those interested in Mines. Post 8vo. pp. 256.

Economic Geology; or Geology in its Relations to the Arts and Manufactures. By David Page, LL.D. 12mo., cloth. Illustrated. London, 1874.

Elements of Metallurgy. A Practical Treatise on the Art of Extracting Metals from their Ores. By Arthur Phillips. Illustrated by numerous engravings on wood. Royal 8vo., cloth. London, 1874.

Pink (William W.) and Webster (George E.). A Course of Analytical Chemistry, qualitative and quantitative; to which is prefixed a Brief Treatise upon Modern Chemical Nomenclature and Notation. (Weale's Series.) 12mo. pp. 180.

Riffault, Vergnaud, and Toussaint. A practical Treatise on the Manufacture of Colors for Painting. Translated by A. A. Fesquet. 8vo., cloth. Illustrated by 80 engravings. Philadelphia, 1874.

Schorlemmer (C.). A Manual of Chemistry of the Carbon Compounds; or, Organic Chemistry. 8vo. pp. 522.

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Thorp (T. E.). A Manual of Inorganic Chemistry. The Non-Metals. Illustrated. 12mo. pp. 399.

United States Textile Manufacturers' Directory, comprising Woollen, Cotton, Silk, Jute, Flax, Linen, and Paper Establishments, and a list of Iron and Steel Manufacturers. 8vo cloth. Boston, 1875.

Vienna Exhibition Reports. Vol. IV. Wine and Beer, by Mr. Vizetelly; Food Products, by G. P. Bevan; International Horse and Cattle Shows, by Lieut. Anstey, R. E.; International Patent Congress, by T. Webster. 8vo.

Introduction to Experimental Physics, Theoretical and Practical, including directions for constructing physical apparatus and for making experiments. By Adolph F. Weinhold. Translated and edited by Benjamin Loewy, R.R.A.S. With a preface, by G. C. Foster, F.R.S. Illustrated by 3 royal plates and 404 wood-cuts. Thick royal 8vo cloth. London, 1875.

Baltus, le Dr. É. Théorie du Microzima, étude théorique et pratique de la pyogénèse. In-8.

Barret. Note sur la combustion des huiles et essences de pétrole. In-8, avec pl.

Beaudrimont, A. Leçon sur le Phylloxera. In-8, avec fig.

Boursin, L. Leçons d'histoire naturelle médicale (cours lithographié. In-4, avec fig. 1re partie: Zoologie médicale. 2me partie: Botanique médicale.

Chaumeux. Premières Leçons de Photographie, par L. Perot de Chaumeux Deuxième edition, revué, 12mo. paper. Paris, 1874.

Collin, Ed. Poids et mesures. Manuel des vérificateurs et des aspirants à cet emploi. In-12.

Cornwall. Manuel d'analyse qualitative et quantitative au chalumeau, d'après les travaux de Berzélius, Plattner, Richter, Dana, J. R. Caswell, etc. Trad. sur la seconde édition américaine par J. Thoulet. Gr. in-8, avec pl. et fig.

Delteil, A. Étude sur la vanille. In-8, avec pl.

Comparaison et transformation des Notations Crystallographiques de Levy, Weiss, Naumann, Dana, par a De Selle. 4to. Paris, 1874.

Droux, Léon. Chimie industrielle. Les Produits chimiques et la fabrication des Savons. Gr. in-8, avec fig. et pl.

Duseigneur-Kléber. Le Cocon de soie. Transformations, description des races, production, maladies des vers à soie, physiologie du cocon et du fil de soie. 2e édit., considérablement augmentée. Gr. in-8, avec. pl.

Fromentel, E. Études sur les Microzoaires ou infusoires proprement dits, comprenant de nouvelles recherches sur leur organisation, leur classification et la description des espèces nouvelles ou peu connues. 1re fasc. 4.

Gautier, L. De la Fabrication du sucre de betteraves. In-8.

Gouillon, F. Méthode pratique d'impression des tissus en couleurs mates, dorées, argentées, bronzées, veloutées et perlées, etc. 2e édit. In-12, avec fig et spécimens d'impression.

Krans. Étude sur le four à gaz et à chaleur régénérée de Siemens. In-8, avec pl.

Kupfferschlaeger, Is. Traité d'analyse chimique qualitative par la voie humide. In-8 (Bruxelles).

Le Bret, E. Manuel medical des eaux minérales.

Lévy, le Dr. B. Amélioration du fumier de ferme par l'association des engrais chimiques et la création de nitrières artificielles. In-12.

Liebert. Traité Complet de Photographie Pratique contenant les decouvertes les plus resentes par a Liebert. Deuxième edition. 8vo. Illustrated with specimen photographs. Paris, 1874.

Liger, F. Fosses d'aisances, latrines, urinoirs et vidanges, Historique, construction, ventilation, etc. Gr. in-8, avec pl et fig.

Lunel, B. Guide pratique pour reconnaître les falsifications et altérations des substances alimentaires et de quelques autres produits les plus généralement employés dans l'industrie et en pharmacie. Ouvrage posthume. In-12.

Marchant, Chs. Du lait et de l'Allaitement. 8.

Paulet, Maxime. Traité de la conservation des bois, des substances alimentaire et de diverses matières organiques. Gr in-8.

Pinson, Alfred, et Jules Petit. Graduation de l'alcoomètre de Gay-Lussac dans l'eau et verification de l'alcoomètre. In-8, avec pl.

Poire, Paul. Chimie. In-8, avec. fig.

Soubeiron, J. L. Nouveau Dictionnaire des falsifications et des médicaments, etc. 8.

Amtlicher Bericht über die Wiener Weltausstellung im Jahre 1873. Erstattet von der Centralcommission des deutschen Reiches für die Wiener Weltausstellung. 1.–12 Hft Braunschweig, 1874.

Bastian, Ad., Schöpfung oder Entstehung. Aphorismen zur Entwicklung des organischen Lebens. gr 8. Jena. 371 pp

Benrath, Dr. H. E., die Glasfabrikation. Mit zahlreichen in den Text eingedruckten Holzstichen. 1. Lieferung. gr. 8. Braunschweig. 199 pp.

Binz, Prof. Dr. C., das Chinin. Nach den neuern pharmakologischen Arbeiten dargestellt. gr. 8. Berlin. 78 pp

Botkin, S. Die Contractilität der Milz und die Beziehung der Infections processe zur Milz, Leber den Nieren und dem Herzen. Berlin, 1874. 8vo. 79 pp.

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Glassen, Dr. A, Grundriss der analytischen Chemie. Quantitative Analyse in Beispielen. Zum Gebrauche für Unterrichtslaboratorien, für Chemiker und Hüttenmänner. Mit in den Text gedruckten Holzschnitten. gr. 8. Stuttgart, 317 pp.

Dietrich, Dr. Th. und Dr. J König, Zusammenstellung und Verdaulichkeit der Futterstoffe. Mit Angabe der Quellen nach den neueren Analysen zusammengestellt. Mit 2 Farbentafeln, die procentische Zusammensetzung und Verdaulichkeit der Futterstoffe graphisch darstellend. Lex.-8. Berlin. 96 pp. mit 2 Tafeln in Folio.

Drageudorff, Prof. Dr G., die chemische Werthbestimmung einiger starkwirkender Droguen und der aus ihnen angefertigten Arzneimischungen. gr. 8. S. Petersburg: 127 pp.

Fortschritte, die, der Physik im Jahre 1870. Dargestellt von der physikalischen Gesellschaft zu Berlin XXVI. Jahrgang. Redigirt von Dr. B. Schwalbe. I. Abtheilung, enthaltend: allgemeine Physik, Akustik, Optik. gr. 8. Berlin. 452 pp.

Frederking K. Grundzüge der Geschichte der Pharmacie und dergenigen Zweige der Naturwissenschaft, auf welchen sie basirt In 2 Abthlgn. Göttingen, 1874. Vandenhoeck & Ruprecht. 8vo. VIII., 303 pp.

Fresenius, C. R. Anleitung zur qualitativen chemischen Analyse. 14. Aufl. Braunschweig.

Giebel, Prof. Dr. C. G., insecta epizoa. Die auf Säugethieren und Vögeln schmarotzenden Insecten nach Chr. L. Nitzsch's Nachlass bearbeitet. Mit 20 Tafeln (woven 18 colorirt) nach Chr. L. Nitzsch's Handzeichnungen. Folio. Leipzig. 322 pp.

Grothe, Dr. H., Bilder und Studien zur Geschichte vom Spinnen. Weben Nähen Vorkommen, Erzeugung, Benutzung, Handel, Verarbeitung, Verbrauch der Gespinnstfasern (Seide, Baumwolle, Flachs, Wolle) in allen Jahrhunderten historich dargestellt. 2. Auflage der „Bilder und Studien zur Geschichte der Industrie und des Maschinenwesens." gr. 8. Berlin. 423 pp.

Grothe, Hm. Die Wolle. Mittheilungen des Vereins der Wollinteressenten Deutschlands über Schafzucht, Wollkunde, Spinnerei, Weberei, Appretur, Färberei, Tuch- und Wollhandel. Berlin, 1874. Grieben 8vo. 796 pp. Mit vielen Steintaf.

Hager, Hm. Commentar zur Pharmacopœa germanica. Mit zahlreichen in den Text gedr. Holzchn. 20. u. 21. Lfg. Berlin, 1874. Springer's Verl. 8vo. II. Bd. pp. 785-977.

Hartmann, E. v., Wahrheit und Irrthum im Darwinismus. Eine kritische Darstellung der organischen Entwickelungstheorie. gr. 8. Berlin. 179 pp.

v. Hauer, Fr. Die Geologie und ihre Anwendung auf die Kentniss der Bodenbeschaffenheit der österreichisch-ungarischen Monarchie. 4 Lfg. Wien, 1874. Hölder. 8vo. p. 241-320. Mit eingedr. Holzschn.

Heussi, Dr. J., der physikalische Apparat. Anschaffung, Behandlung und Gebrauch desselben. Für Lehrer und Freunde der Physik. Mit über 500 in den text gedruckten Holzschnitten. 1. Hälfte gr. 8. Leipzig. 256 pp.

Hirsch, Director Dr. A., die Sonne. Vortrag. gehalten in der Neuenburger Gemeinnützigen Gesellschaft am 28. März 1874. Mit 2 Tafeln Abbildungen in Farbendruck. gr. 8. Basel. 41 pp.

Hofmann, C. Praktisches Handbuch der Papierfabrikation. Mit zahlreichen in den Text gedr. Holzschn. und lith. Taf. 1 Lfg. Berlin, 1874. Springer's Verl. 4to. 56 pp.

Hofmann, Prof. Dr. A. W., Bericht über die Entwickelung der chemischen Industrie während des letzten Jahrzehends im Verein mit Freunden und Fachgenossen erstattet. Autorisirter Abdruck aus dem "Amtlichen Berichte über die Wiener Weltausstellung im Jahre 1873." gr. 8. Brawnsweig. 350 pp.

Jahrbuch der Erfindungen und Fortschritte auf den Gebieten der Physik und Chemie, der Technologie und Mechanik, der Astronomie und Meteorologie. Herausgegeben von Prof. Dr H. Hirzel und Prof Dr. H Gretschel. 10 Jahrg. 1874. Mit 27 in den Text gedrukten Abbildungen. 8. Leipzig. 422 pp.

Knublauch, Dr. O. Qualitative chemische Analyse nach Gleichungen in neuen Formeln. Lex.-8. Bon. 26 pp

Kolbe, H., und C Neubauer, die Salicylsäure in ihren verschiedenen Wirkungen. Drei Abhandlungen (Aus dem Journal für praktische Chemie). gr. 8. Leipzig.

Kutcher, Inspector E, die neue Aufbereitungs-Anstalt bei Clausthal. Hierzu 1 Atlas mit 10 Tafeln und 4 Texttafeln. (Separatabdruck aus der Zeitschrift für das Berg-Hütten- und Salinen-Wesen in dem Preussischen Staate) 4 Berlin. 20 pp. mit Atlas in Folio.

Leonhard, G. Grundzüge d. Geognosie u. Geologie. 3. Aufl. 3. Lfg. Leipzig.

Lockyer, S. N., das Spectroskop und seine Anwendungen. Eine übersichtliche Darstellung des gesammten Gebietes der spectralanalyse. Eingeführt und bewortet durch Dr. H. Schellen. Mit 61 Figuren und 1 farbigen Spectraltafel. gr. 8 Braunsweig. 150 pp.

Lützow, C. v. Kunst und Kunstgewerbe auf der Wiener Weltausstellung 1873. Unter Mitwurkung von H Auer, Br Bucher, R. v. Eittelberger, etc. herausgegeben. Mit 388 Holzschnitten und 5 Kupfern. 4. Leipzig. 536 pp

Meyn, Dr. L., die natürlichen Phosphate und deren Bedeutung für die Zwecke der Landwirthschaft. gr. 8. Leipzig. 168 pp.

Miller, Dr. W., über die Bestandtheile des flüssigen Storax und einige Derivate derselben. gr. 8. München. 39 pp.

Mohr, F. Chemische Toxicologie. Braunschw.

Rammelsberg, Prof. Dr. C. F., Leitfaden für die qualitative chemische Analyse, für Anfänger bearbeitet. 6. Auflage gr. 8. Berlin. 161 pp.

Rauke, Prof. Dr. med. J., Grüncuge der Physiologie des Menchen mit Rücksicht auf die Gesundheitspflege. Für das praktische Bedürfniss der Aerzte und Studirenden zum Selbststudium bearbeitet 3. umgearbeitete Auflage. Mit 265 Holzchnitten. gr. 8. Leipzig 975 pp.

Sadebeck, Alx. Die Krystallisation des Bleiglanzes. Mit. 3 lith Tafeln. Berlin, 1875. Mittler & Sohn. 8vo. 54 pp.

Smith, Edward. Die Nahrungsmittel 2 Thle. I. Feste Nahrungsmittel aus d. Thier- u. Pflanzenreich. Mit 16 Abbildgn. u. Holzschn. II. Flüssige u. gasige Nahrungsmittel. Mit 3 Abbildgn. in Holzschn. Leipzig.

Szoan, Dr. med. F., die Medicin auf der Wiener Weltausstellung 1873. Mit Berücksichtigung der Chemie und Pharmacie. Skizzen. gr. 8. Riga. 139 pp.

Vogt, Dr. A., Trinkwasser odor Bodengase. Eine Stretschrift zur Beleuchtung der Tagesgen über die Entstehung des Typhus und dessen Bekämpfung. Mit 2 lithographirten Tafeln. Separatabdruck aus dem correspondenzblatt für Schweizer Aerzte. Hoch 4. Basel. 79 pp.

Walchner, F. H. Die Nahrungsmittel des Menschen, ihre Verfalschungen und Verunreinigungen. Nach den besten Quellen dargestellt. Berlin, 1875. Springer's Verl. 8vo. VIII., 324 pp.

Weber R. Die Papier-Industrie. Brunschw.

Weiss, Dr. med. L Beiträge zur quantitativen Bestimmung des Zuckers auf optischem Wege. gr. 8. Wien. 24 pp.

Werner, Hg. Handbuch des Futterbaues auf dem Ackerlande und der Fütterung der landwirthschaftlichen Nutzthiere. Mit 76 Holzchn auf 35 Tafeln. Berlin, 1875. Wiegandt, Hempel & Parey. 8vo. VIII., 824 pp.

Wiessner, A. Das. Atom odor d. Kraftelement d. Richtung als erster Wirklichkeitsfactor. 8.

BREVITIES.

THE PRIESTLEY MEMORIAL ALBUM.—Those who assembled in August last around the grave of Priestley to commemorate the one hundredth anniversary of the discovery of oxygen, will long bear in pleasant remembrance the warm reception extended them by the hospitable residents of Northumberland, and especially the courteous attentions of the worthy descendants of the great theologian and chemist. Those who attended the meetings in the commodious school-house, will remember that just before adjourning on the second day the Finance Committee reported a balance in the treasury of forty dollars and some cents; and, thereupon, on motion of Mr. Elwyn Waller, it was resolved that the balance in the hands of the treasurer be expended for a suitable photographic album, and that all the gentlemen who placed their names on the Treasurer's list be requested to send their *cartes de visite* to Dr. H. Carrington Bolton, School of Mines, Columbia College, New York. Also, their autographs on a separate piece of paper, to be inserted below their photographs.

The Memorial Album to be presented to Dr. Joseph Priestley and his family, to be preserved by them and their descendants until the meeting of the next Centennial of Chemistry in Northumberland, Pa., on the 1st of August, 1974.

The treasurer accordingly paid over the balance to the committee of one named in the resolution, and he immediately issued circulars reminding the gentlemen of their part of the duty assigned. Many responded promptly, others postponed their visit to the photographer, and some have not yet fulfilled their obligations; gradually, however, autographs and *cartes de visite* accumulated, an album was secured, and recently (April, 1875) the partially filled album was forwarded to Dr. Joseph Priestley. The album is bound in red Russia leather, and is held in a case of the same material.

The inscription reads: "Presented to Dr. Joseph Priestley by the chemists assembled at Northumberland, Pa., August 1, 1874, to commemorate the one hundredth anniversary of the discovery of oxygen by his illustrious ancestor."

Following this, we find in order a series of twelve 6×8 photographs, taken at Northumberland by Louis H. Landy. These include a fine portrait of Rev. Dr. Joseph Priestley; a view of his residence in Northumberland; an interior view of the Loan Exhibition Room at Northumberland; three groups of Priestley's chemical, physical, and electrical apparatus; the destruction of Dr. Priestley's house in Birmingham (copied from a rare old engraving in possession of the Priestley family); the headstone of Priestley's grave; three views in the town of Northumberland; and the group of chemists who were gathered at Northumberland. This last picture contains seventy-two figures, and is a remarkably clear photograph.

Following these large pictures we find, arranged in alphabetical order, the photographs of the chemists who "placed their names on the treasurer's list." We noticed a few vacant spaces which we are certain will be quickly filled by the delinquents. Finally, on two sheets of bristol-board the autographs of the chemists are pasted, also in alphabetical order, and afford an entertaining chirographical study.

Those who participated in the "Centennial" gathering, will probably learn with satisfaction of the successful completion of this tribute of esteem and memorial of a delightful and interesting celebration.

CELEBRATION OF THE CENTENARY OF PRIESTLEY'S DISCOVERY OF OXYGEN, AT PARIS.—The impulse on the part of the scientific world to celebrate the one hundredth anniversary of the discovery of oxygen by Joseph Priestley, appears to have been well nigh universal. Besides the memorable ceremonies at Northumberland and at Birmingham, Paris had its own modest celebration.

On Sunday, August 2d, a select audience of about one hundred persons assembled in the "Salle des Ecoles," Paris, and listened to an address eulogistic of Priestley and his labors, delivered by M. W. de Fonvielle, the well-known aeronaut and author. His address has reached us in the shape of a neat little pamphlet of thirty-six pages, bearing the following title: "Célébration du premier Centenaire de la Découverte de l'Oxygène, 1er Août, 1774. La Vie et les Travaux du Docteur Priestley, par M. W. de Fonvielle. Paris, 1875. 16mo."

The pamphlet is embellished by a wood-cut of the statue erected to Priestley in Birmingham. The address relates succinctly the most interesting points in the life and labors of Dr. Priestley, without going into details Special reference is made throughout to his liberal political views, and the most is made of his sympathy with the French republicans; some of the facts have an entirely different

light thrown upon them from the French point of view. We notice that the erroneous statement of his death being hastened by poison is here repeated, modified, however, with a "perhaps." The following sentence shows M. de Fouvielle's position with regard to Lavoisier's claims to the discovery of oxygen: "Already in the month of November following, Priestley's experiments were repeated in France on an immense scale, thanks to the liberality of Frudaine of the Academy of Sciences. Lavoisier decomposed the red oxide of mercury in the gardens of the Infanta, by means of a lens of enormous size compared with that used by Priestley. Instead of being a foot in diameter, this lens measured four feet, and its interior capacity was such that it could contain one hundred and forty pints of alcohol. Lavoisier, understanding too well, perhaps, the importance of Priestley's discovery, *the glory of which he tried to absorb*, pursued it with all the force of his genius, and did not relinquish it until the theory of combustion had been founded." The italics are our own.

The prevailing bitterness of feeling between France and Prussia intrudes itself even in this discourse. Looking forward to the progress of science in 1974, the author incidentally brings in the following sentence: "It is impossible to foresee the nature of the political events which will have disturbed the surface of the European world, to predict whether Berlin will still be found on the map, or whether the enemy shall have ploughed and sowed salt on the ruins of Paris."

Allusion is made in a footnote to the reunion of American chemists at the grave of Priestley, and to that of the British chemists at Birmingham, which were held simultaneously with that in Paris.

And now Germany remains to be heard from. Was she behindhand in this international celebration? Priestley's connections with Germany were very slight; but when we see the countrymen of Lavoisier cheerfully rendering homage to his rival, why should the Germans stand aloof?

A Beautiful Experiment in Instantaneous Crystallization.—Peligot.—Dissolve 150 parts by weight hyposulphite of soda in 15 parts boiling water, and gently pour it into a tall test-glass so as to half fill it, keeping the solution warm by placing the glass in hot water. Dissolve 100 parts by weight sodic acetate in 15 parts hot water, and carefully pour it into the same glass, the latter will form an overlying layer on the surface of the former, and will not mix with it. When cool, there will be two supersaturated solutions. If a crystal of sodic hyposulphite be attached to a thread and carefully passed into the glass, it will traverse the acetate solution without disturbing it, but, on reaching the hyposulphite solution, will cause the latter to crystallize instantaneously in large rhomboidal prisms with oblique terminal faces. When the lower solution is completely crystallized, a crystal of sodic acetate similarly lowered into the upper solution will cause it to crystallize in oblique rhombic prisms. The appearance of the two different kinds of crystals will not fail to astonish those not acquainted with this class of experiments.—*La Nature.*

Erection of a Monument to Scheele.—The Society of Pharmaceutists, of Stockholm, have opened a subscription for the purpose of erecting a monument to the memory of Scheele. Mr. Génévoix, in a note addressed to the chemists of France inviting them to join the movement, uses the following words: "More than a century has passed since Scheele published his first essay on chemistry in the memoirs of the Stockholm Academy of Sciences, and the one hundredth anniversary of his death, which took place May 24, 1786, is not far distant.

"Although to Scheele was allotted only fifteen years in which to pursue scientific research, he contributed annually such remarkable discoveries in the domain of chemistry that they exerted a mighty influence on industry, metallurgy, and agriculture, and have been more influential in the intellectual development of this century than diplomatic negotiations and battles, and have entitled the humble pharmaceutist of Kœping a high position among the savants of all ages and countries." Scheele's discoveries are thus summed up: Oxygen, nitrogen, fluorine, chlorine, baryta, manganese, tungsten, molybdenum, prussic acid, hydrosulphuric acid, oxalic, tartaric, citric, malic, gallic, lactic, mucic acids, glycerine, the composition of the air, the general distribution of phosphorus in nature, etc.

Chemical Laboratory for Women Students.—The Women's Medical College, of Pennsylvania (Philadelphia), has recently moved into the handsome and commodious buildings erected expressly for the institution. Unusual facilities are provided for instruction in chemistry. Too often is the study of chemistry in medical colleges confined to a routine course of lectures, illustrated by experiments more or less appropriate to the needs of the hearers, until the latter begin to regard chemistry as a sort of necessary evil of no great importance to the embryo physician. And now we find a women's medical college setting a good example to many of the medical colleges for the sterner sex. Adjoining the capacious lecture-rooms of the new building, is a conveniently arranged and well-mounted laboratory, not for the professor's use only, but where practical work is actually performed by the women students. A class of sixteen ladies is now pursuing a course in analytical chemistry under the instruction of the professor, Rachel L. Bodley, A.M. Six hours a week, at least, are devoted to laboratory practice. Practical instruction in pharmacy is also given in another laboratory devoted to this branch.

American Association for the Advancement of Science.—In accordance with the vote of the Association at the Portland meeting, accepting the invitation from Detroit, the Twenty-fourth Meeting of the Association will be held at Detroit, Michigan, commencing at 10 o'clock A. M., on Wednesday, the 11th day of August, 1875.

The headquarters of the Association will be at the Russell House on Monday and Tuesday; on Wednesday it will be transferred to the City Hall and Court House, directly opposite.

Members will report at the headquarters immediately on arrival.

At an early date the Local Committee will issue their circular to members of the Association, giving details relating to the arrangements made for the accommodation of members while in Detroit, and such other information as may be of interest to those intending to be present at the meeting, including any facilities offered by the railroads, reduction of hotel prices, contemplated excursions, etc.

Professor F. W. Clarke, of Cincinnati, appointed by the Chemical Subsection of the Hartford meeting to notify chemists of the organization of a *Permanent Subsection of Chemistry*, requests that attention be called to the fact that the subsection is a permanent organization, and states that the general interest awakened among the chemists indicates a large gathering at Detroit of those specially interested in that department.

The attention of persons specially interested in entomology is directed to the action taken by the entomologists at the Hartford meeting, and to the fact that there will be a meeting of the Entomological Club of the Association at Detroit, on Tuesday, August 10th (the day preceding the meeting of the Association), at which all interested are invited to be present.

It was also suggested at the last meeting that special efforts be made to bring the ethnologists and archæologists together at Detroit in order to form a permanent subsection of anthropology, and it is probable that definite action will be taken on the subject at the coming meeting.

In order to receive the circular of the Local Committee without fail, it is desired that all members now planning to attend the meeting should send their addresses to Frederick Woolfenden, Esq., *Secretary of the Local Committee*, Detroit, Michigan.

Officers of the Detroit Meeting.

President.—J. E. Hilgard, of Washington.
Vice-President, Section A.—H. A. Newton, of New Haven.
Vice-President, Section B.—J. W. Dawson, of Montreal.
Chairman of Chemical Subsection.—S. W. Johnson, of New Haven.
Permanent Secretary.—F. W. Putnam, of Salem.
General Secretary.—S. H. Scudder, of Cambridge.
Secretary of Section A.—S. P. Langley, of Allegheny, Pa.
Secretary of Section B.—N. S. Shaler, of Newport, Ky.
Treasurer.—W. S. Vaux, of Philadelphia.

Standing Committee.

Past Presidents.—Wm. B. Rogers, of Boston; Joseph Henry, of Washington; Benjamin Peirce, of Cambridge; James D. Dana, of New Haven; James Hall, of Albany; Alexis Caswell, of Providence; Stephen Alexander, of Princeton; Isaac Lea, of Philadelphia; F. A. P. Barnard, of New York; J. S. Newberry, of New York; B. A. Gould, of Boston; T. Sterry Hunt, of Boston; Asa Gray, of Cambridge; J. Lawrence Smith, of Louisville; Joseph Lovering, of Cambridge.

The President, Vice Presidents, Secretaries, and Treasurer of the Detroit meeting.

As Officers of the Hartford Meeting.—John L. LeConte, of Philadelphia; C. S. Lyman, of New Haven; A. C. Hamlin, of Bangor.

From the Association at large.—Six Fellows to be elected on the first day of the meeting.

ERRATA OF VOL. V.

Page 59, 1st column, 29th line from top, for "Shiel" read "Schiel."

Page 212, 1st column, 19th line from bottom, for "*Gold-covered*" read "*Gold-lined.*" 1st column, 12th line from bottom, for "while —— placed," read "while a chemist should not consider any time lost which is needed for accuracy of results, yet he need not consume time attempting what is called accuracy of weighing far beyond the limit of error of the circumstances under which a balance in a laboratory, with the containing vessels of platinum, glass, and porcelain (used to contain the materials weighed), is placed."

Page 215, 1st column, 32d line from top, for "Denis Lachaire," read "Denis Zachaire." 2d column, 3d line from top, for "Grosses Vollstandiges Universal, Lexicon," read "Grosses Vollstandiges Universal Lexicon."

Page 228, 2d column, 15th line from bottom, for "Sonnenschin" read "Sonnenschein."

Page 277, 1st column, 22d line from bottom, for "sulphate of zinc" read "sulphate of lime."

Page 314, 2d column, 9th line from top, for "CHOH" read "CH_2OH." 11th and 14th lines, for "*carbhydral*" read "*carbhydryl.*"

Page 348, 1st column, 9th line, for "basic," read "baric."

Page 364, 2d column, paragraph commencing "I do not doubt," should follow the next paragraph.

Page 372, 2d column, line 16, for "McVaughan," read "Mr. Vaughan."

Page 373, 1st column, line 16, for "fixed" read "fixes."

Page 374, 1st column, line 12 above the foot note, for "contain" read "sustain."

Page 375, 1st column, line 23 from bottom, for "chemistry. Not" read "chemistry; not." Line 21 from bottom, insert period after "science" and before "Priestley." Line 14 from bottom, for "Cartrite" read "Carlsile." Line 10 from bottom, for "Biddoes" read "Beddoes." Line 8 from bottom, for "uniting" read "united." 2d column, line 18, for "natural" read "national."

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